KNIGHT'S AMERICAN MECHANICAL DICTIONARY

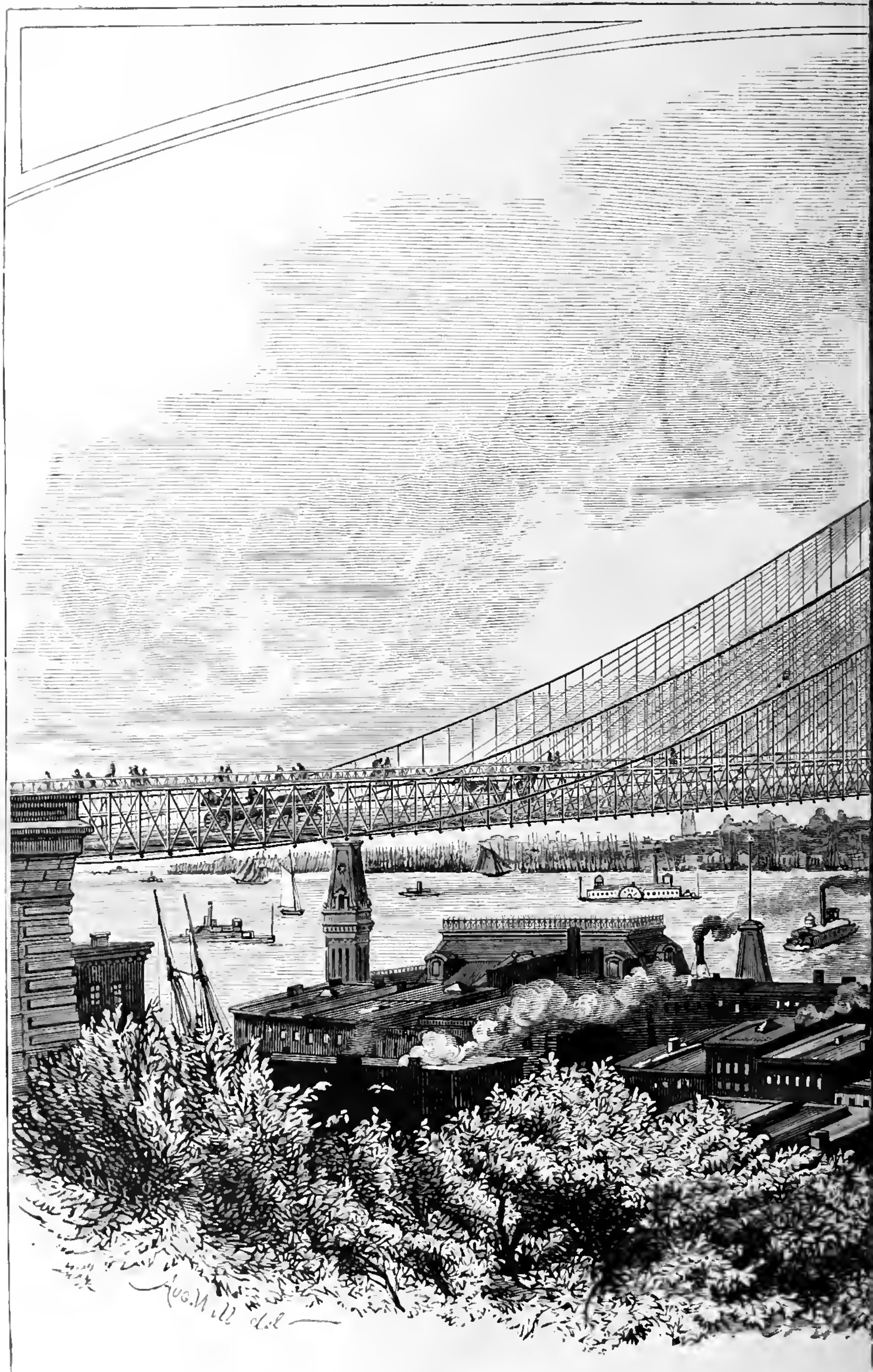
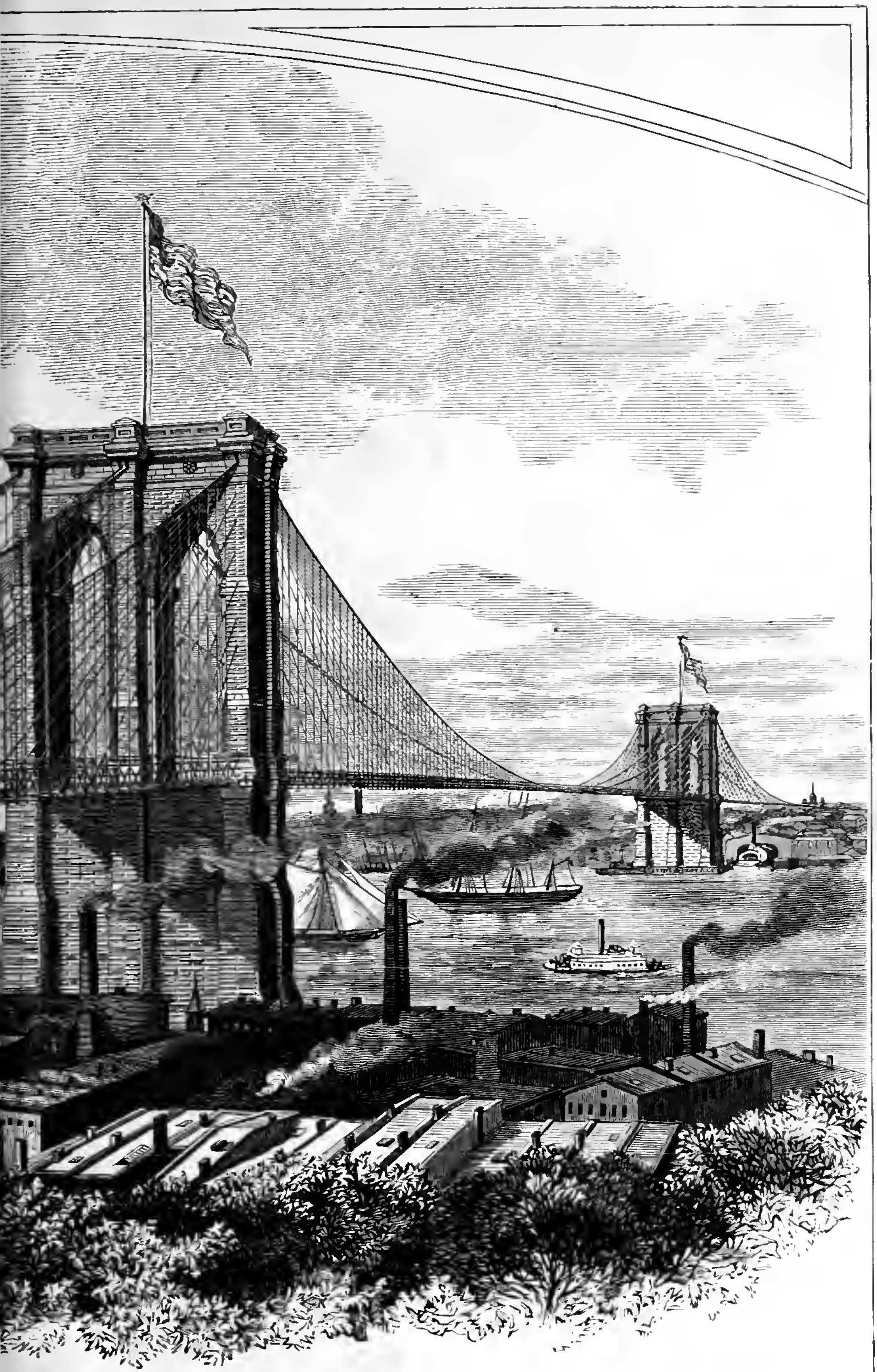


PLATE I

SUSPENS

BETWEEN BROOKL



N BRIDGE.

ND NEW YORK CITY.

See *Suspension Bridge*.

KNIGHT'S
AMERICAN
MECHANICAL DICTIONARY.

A DESCRIPTION OF TOOLS, INSTRUMENTS, MACHINES, PROCESSES, AND ENGINEERING; HISTORY OF INVENTIONS; GENERAL TECHNOLOGICAL VOCABULARY;

AND

DIGEST OF MECHANICAL APPLIANCES IN SCIENCE AND THE ARTS.

By EDWARD H. KNIGHT,

CIVIL AND MECHANICAL ENGINEER, ETC.

Illustrated

WITH UPWARDS OF SEVEN THOUSAND ENGRAVINGS.

VOLUME I. — A-GAS.

"Thus Time brings all things, one by one, to sight,
And Skill evolves them into perfect light." — LUCRETIUS, Book V.

First Steam Engine.

BOSTON:

HOUGHTON, MIFFLIN AND COMPANY.

The Riverside Press, Cambridge.

1882.

RIVERSIDE, CAMBRIDGE:
ELECTROTYPED AND PRINTED BY
H. O. HOUGHTON AND COMPANY.

PREFACE.

MORE than twenty years ago the author commenced collecting memoranda of mechanical and scientific information with a view to forming a systematic digest, but without any well-defined prospect of its publication. Somewhat over four years ago he was requested by the present publishers to undertake the work which is now put forth, and since then has devoted to it the principal part of his time. While engaged in this duty, much encouragement has been afforded by repeated assurances that there was great need of such a work, and by ready and valuable assistance from personal friends of the author, experts in various departments of science and industry.

After carefully considering the mode of presentation, it was thought best to adopt the form of a *Dictionary*, — a "word-book," which describes things in the alphabetical order of their names, — and not that of an *Encyclopædia*, which considers them in the order of their scientific relation. A *Dictionary* answers directly the questions propounded; an *Encyclopædia* is a collection of treatises.

The aim has been to place the information in the most systematic order, so that any specific point of detail may be readily reached when required. A book or a mind, though a closely packed repository, unless order has supplemented industry, is unavailable in an emergency, reminding one of "the fool i' the forest": —

> "And in his brain —
> Which is as dry as the remainder biscuit
> After a voyage — he hath strange places crammed
> With observation, the which he vents
> In mangled forms."

As to the general scope of the book and the method pursued in its preparation, it must, in the main, speak for itself. While the greater portion of the work is occupied, of course, by details of solid import, there is some little romance and a great deal of interest in the study of the *History of Inventions*. Without deviating into irrelevancy, the author has sometimes become

> "A snapper-up of unconsidered trifles,"

worthy of a more careful estimate.

"First the blade, then the ear, then the full corn in the ear," is the natural order in invention, as well as in other departments of mind and in the Kingdom of Grace. When we read Pliny's account of the reaping-machines in the plains of Rhœtia, about A. D. 70, we wonder that, the idea once blocked out, the machine should afterwards relapse into utter oblivion. It was the time that was "out of joint." At the latter end of the last century and the early portion of the present, attention was again directed to the reaper, and the machine described by Pliny, and by Palladius three centuries later, was reïnvented exactly: it yet survives in our *clover-header.* This instance is by no means singular. One favorite form of rotary steam-engine, upon which treatises have been written within two years past, is but a reproduction of the æolipile of Hero, which revolved in the Serapeum of Alexandria in the second century B. C. Many similar examples might be cited, but this duty belongs to the body of the book, and not to the Preface.

In the adaptation of machinery to common use, our country excels all others: for instances, the reaper and the sewing-machine. These became useful instruments in American hands, not merely by facility of adaptation, but, most distinctly, by the invention of those all-important points which constituted success. A reasonable share of space in this work, therefore, has been devoted to the feature of *Mechanical Evolution*; the aim being to give not only the present state of the respective arts, but also the various stages by which the relatively perfect appliances attained their development.

Subject-matter Indexes are introduced in their alphabetical order throughout the body of the work, and a list of the principal ones follows this Preface. These will afford means for ascertaining the names of the technical implements of the respective Arts, Manufactures, and Trades, and also serve as cross-indexes for the terms so cited. The subjects indicated are necessarily considered in their alphabetical order; for instance, the five hundred "Agricultural Implements" are not treated in a single article, — as they would be in an Encyclopædia, — but each in its own place under its own name. Their assemblage, however, in a single list, or index, is convenient for many purposes, and it is estimated that over twenty thousand technical words have been thus gathered in groups.

Every useful machine is an illustration of the laws which the Creator has impressed upon matter. There is a touch of sublimity in the thought that while so much around us is mundane and fleeting, there are some things in which we are allied to the intelligences of other worlds. Mechanics is a science and an art, and Mathematics affords the statement of its laws. Whatever may be the terms and conditions of other existences, and in whatever mode their experiences and attainments may find expression, it is certain that we have a mutual interest in these allied sciences. As every thread of knowledge is a filament of the great central cluster and will lead thereto if rightly followed, so may each study form a clue which will lead us towards the Source whence emanates all that is worth knowing.

With these convictions, the author cannot be otherwise than profoundly impressed with the majesty of his subject and his own insufficiency, but the philosopher will consider leniently this attempt to summarize the mechanical appliances which have been developed by the experiences of at least forty centuries.

EDWARD H. KNIGHT.

WASHINGTON, D. C., December 15, 1873.

LIST OF SPECIFIC INDEXES.

The Specific Indexes in the following list are to be found in their alphabetical places in the body of the work. Each index embraces the technical appliances, etc., appertaining to its subject.

Agricultural and Husbandry Implements.
Air Appliances and Machinery.
Alarms.
Alloys.
Artificial and Prosthetic Appliances.
Astronomical Instruments.
Axes.
Baths.
Batteries.
Bits, Boring.
Blacksmith's Tools and Appliances.
Blocks, Nautical.
Boats.
Boilers.
Bolts.
Bookbinder's Tools and Processes.
Boxes.
Bridges.
Brushes.
Calculating and Measuring Instruments.
Carpentry.
Carpets.
Carriages (see Vehicles).
Cars.
Cements.
Chairs.
Chisels.
Civil Engineering.
Clamps.
Compasses.
Cooper's Tools.
Cotton, Flax, Wool, Hemp, and Silk.
Couplings.
Currier's Tools.
Dental Apparatus and Appliances.
Dilators.
Docks.
Domestic Appliances.
Drafting Instruments and Appliances.
Drills.
Dryers.
Electrical and Magnetical Appliances.
Engraving.
Escapements.
Fabrics.
Faucets.
Files.
Filters.
Fine Arts.
Fire-arms.
Forceps.
Forks.
Fortification.
Founding.
Furnaces.
Gages.
Gas Appliances.
Gearing.
Glass.
'Graph.
Grinding and Polishing.
Grinding-Mills.
Hammers.
Hoisting-Machines.
Hooks.
Horological.
Hydraulic Engineering and Devices.
Ice, Manufacture and Uses of.
Indicators.
Jacks.
Jaw Tools.
Joints.
Keys.
Knitting.
Knives.
Lamps.
Lathes and Appliances.
Leather, Tools, Machines, and Appliances.
Lenses.
Levels.
Lights and Photic Appliances.
Locks.
Looms (see Weaving).
Masonry and Architecture.
Measures.
Metallurgy.
Metal-Working Tools and Machines.
Meters.
Micrometers.
Mills.
Mining Appliances and Terms.
Musical Instruments.
Nails.
Nautical Appliances.
Needles.
Optical Instruments.
Optical Toys, Scenes and Effects.
Ore (see Metallurgy).
Paper.
Photography.
Piles.
Pipes.
Planes.
Plasterer's Tools and Work.
Plows.
Plumbing and Sheet-Metal Work and Tools.
Pottery and Clay.
Presses.
Printing.
Projectiles.

Propellers.
Pulleys.
Pumps.
Punches.
Pyrotechnics.
Rails.
Railway Engineering and Plant.
Registers.
Regulators.
Rollers.
Saddlery and Harness.
Sails.
Saws.
'Scope.
Sewing-Machines and Attachments.
Shears.
Shipwrighting.
Signals.
Speculums.
Springs.
Steam-Engine (Parts and Appliances).
Steam-Engines (Varieties).
Stoves and Heating Appliances.
Sugar-Machinery.
Supporters.
Surgical Instruments and Appliances.
Syringes.
Telegraphs.
Telescopes.
Tinman's Tools.
Tobacco.
Traps.
Tubes.
Turning-Tools.
Type.
Valves.
Vehicles (Tools, Appliances and Parts of).
Vehicles (Varieties).
Ventilators.
Vessels.
Watches.
Water-Elevators.
Water-Wheels.
Weapons and Accouterments.
Weaving.
Wheels.
Wire-Working.
Wood-Working Tools and Machines.
Wrenches.

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KNIGHT'S MECHANICAL DICTIONARY.

A.

Ab'a-cis'cus. A small square stone or tessera for a tesselated pavement.

Ab'a-cus. An instrument used from time immemorial in performing the operations of addition and subtraction.

A smooth board with a marginal ledge formed the writing and calculating table of the Greek schoolboys and accountants. For writing, it was strewn with sand, upon which marks were made with a stylus; thus they learned to write, and on this they executed geometrical figures. The primary use of the board is indicated by its name, which is derived from the first three letters of the Greek alphabet, Α Β Γ. It was called an *abax*, and retains the name, but slightly modified.

The *abax* strewed with sand is the *pulvis eruditus*, or the *Mensa Pythagorea* of classic authors.

For arithmetical calculation, the same board was used without the sand, to contain the counters, which were arranged thereon in parallel rows, representing respectively units, tens, hundreds, thousands, etc. Solon (about 600 B. C.) refers to the arbitrary denominations of the several lines, in a metaphor which compares the different grades of society to the different values of the counters in the several rows.

The counters were pebbles, beans, or coins, especially the former. The Greek word for the counters of the *abacus* was derived from a word signifying a pebble. Pythagoras, the great arithmetician, hated beans, — an antipathy he derived from the Egyptian priests, his instructors. About the same time Daniel was eating pulse in Babylon without grumbling, and Horatius was hewing down the bridge of the Janiculum.

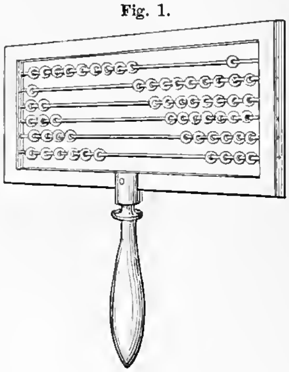
The Roman word *calculus*, from which we derive our word *calculate*, was the diminutive of *calx*, a stone, and referred to the pebbles which formed the counters of the abacus.

Sometimes the counters were shifted to the right in counting, sometimes to the left. It is stated that the Greek and Roman practices differed in this respect. Several varieties of instruments are represented on the ancient monuments.

The step was easy from a flat board with shifting counters arranged in rows, to a board with grooves in which the pebbles were rolled. Afterwards we find pellets strung upon wires, and thus the Chinese have used it for ages.

The illustration shows the last-mentioned form of the device, arranged for decimal counting. The number indicated by the beads on the right hand of the frame is 198,764, and it will be seen that by transposing the beads to one side or the other, as required, either addition or subtraction may be readily performed. A person accustomed to the instrument will perform these operations with great rapidity and accuracy. The Chinese term the instrument a *swan-pwan*, and are very dexterous in its use.

Fig. 1.



Abacus.

The original of the Chinese abacus has been supposed to be the "knotted cord," used in China for keeping accounts before the invention of writing. The knots are made movable by substituting sliding beads. Hence likewise seems to have been derived the mode of keeping the Chinese *Tung-tien*, or perforated coins, which are strung upon a cord.

One form of the Chinese abacus has two compartments, five beads in one and two in the other; the former have the value of one each, the latter five each. The wires are nine in number, and each runs through the two compartments.

The Romans, contrary to the customs of the Phœnicians and Greeks, from whom they received their alphabet, expressed their numbers 1, 2, 3, not by the first letters of the alphabet, but by strokes,

I II III;

in this respect unconsciously copying the Chinese numerals of the same value,

—

=

≡

The difference in the direction of the figures gives the numerals in each the same position *across* the column; for the Roman writing is in horizontal column, the Chinese vertical.

The resemblance between the Chinese and Roman numerals extends much further than the above, and shows a common origin.

Perhaps it may be accounted for by the studies of Pythagoras in India, and the subsequent instruction of Numa in the school founded by the sage of Samos in Crotona, a city of Magna Græcia. (*Plutarch.*)

Hindoo (commonly known as "Arabic").	Roman.	Chinese
10	X	十
11	XI	十一
12	XII	十二
13	XIII	十三
20	XX	十十
30	XXX	十十十

The resemblance cannot be accidental. Pythagoras and Kung-fu-tze (Confucius) were contemporaries.

Another mode among the Chinese of expressing 20, 30, etc. was by placing 2, 3, etc. before the sign of ten; so that they in some degree anticipated the Hindoos, where a numeral before the zero expressed so many tens, e. g.

Chinese.	Arabic.
三十	30

The great advance in the Hindoo over the other systems of notation was in giving a *place value* to figures. In Sanscrit, the initial letters of the Sanscrit names of the Indian numerals are employed from 1 to 9. The original zero was a dot. The Greek letter omicron (o) was afterwards substituted, and forms our naught. It is amusing to see the combination of Hindoo and Roman figures during the fourteenth and fifteenth centuries, such as

(Written.)	(To be read.)
x 3	13
x 4	14
40 1	41, etc.

Showing that the force of the zero and the value from position were not understood at first, even when the new characters had become customary.

The decimal and duodecimal systems of arithmetic were in use in Egypt at the earliest period of its known history. For the respective systems the numbers of counters in the rows would vary, each line representing a multiple by 10 or 12 of the line below it. There is no representation of the abacus for counting on the Egyptian monuments. "The Assyrians counted by 60's as well as by 100's."—*Rawlinson.*

The instrument was probably invented by the Chinese, and passed thence westwardly through India and Arabia to Europe. The evidences of ancient trade on this line are found at both ends and at intermediate points. The glass bottles with Chinese inscriptions, found with the Egyptian mummies, prove the existence of trade relations between those nations before the founding of Athens, and also dissipate the myth of Pliny as to the discovery of glass by certain mariners of Phœnicia, a few centuries previous to the time at which he made his curious collection of vagabond information.

Over this famous route travelled the mariner's compass, gunpowder, the art of glazing pottery, of making paper of pulp, and much else that we value. Felting of animal fiber was also derived from Asia, but probably entered Europe by a more northern route.

The Greek and Roman numeration was decimal, but their system of notation was very unfortunate, as any one may ascertain by trying a sum in multiplication:

CCXLVIII
XLV
?

The Oriental system of notation was introduced by the Arabs, and was credited to them, but they more properly term them *Indian* numerals, referring to their derivation from the Hindoos. This system of notation passed with the Saracens along the northern coast of Africa, and was carried by them into Spain. The caliphate of Cordova was established by Abderahman, A. D. 755, and the university at that place was founded A. D. 968. At this distinguished seat of learning was educated the famous Gerbert of Auvergne. This enlightened ecclesiastic was successively a schoolmaster at Rheims (where he introduced the abacus, the Arabic numerals, the clock, the organ, and the globe), archbishop of Ravenna, and, eventually, Pope Sylvester II., to which position he was elevated by the decree of the Emperor Otho III. Patron and prelate died of poison shortly after, about A. D. 1002.

Gerbert was probably the first to use in a Christian school the nine digits and a cipher, which proved, as William of Malmesbury said, "a great blessing to the sweating calculators."

A translation of Ptolemy, published in Spain in 1136, used the Hindoo notation. The Hindoo numerals were introduced into England about A. D. 1253.

The accounts of the kings of England, previous to the Norman Conquest — and the same is probably true of most contemporary European nations — were calculated by rows of coin disposed as in the abacus, that is, placed in parallel rows which represented gradually increasing denominations in the ascending series. At the Conquest an amplification of the same idea was introduced, the calculations being performed by the *teller*, at a large table called a *saccarium.* This had a ledge around it, and was covered by a black cloth ruled with *chequer* lines. Hence the word *Exchequer,* as applied to English national finances.

In the twelfth century, this table was five by ten feet, and its cloth cover was divided by vertical and horizontal lines. The horizontal bars represented pence, shillings, pounds, tens, hundreds, thousands of pounds. Coins were used for counters; the first and lowest bar advanced, by dozens, the number of pence in the shilling; the second, by scores, the number of shillings in the pound; the higher denominations by tens. This was a true *abacus,* and was used down to a comparatively recent period.

The accounts of merchants were kept in Roman numerals till the close of the sixteenth century, and the use of the abacus was maintained to a much later date. Until 1600 its use was a branch of popular education.

Offices for changing money came to be indicated by a checker-board, and the sign was afterwards appropriated by the keepers of inns and hostelries. This shows that people met at such places to settle accounts, a friendly drink being a tribute to "mine host." The Jerusalem and Lloyd's coffee-houses are noted in the history of trading companies; the latter especially. The checker-board on the doorpost of the tavern is about the last phase of the *abacus,* in Europe at least.

The checkers on the posts of an inn door are to be seen upon a house in disentombed Pompeii.

The *tally* system was also introduced into England at the Norman Conquest. This was not for calculating, but for keeping accounts. The name of the device came with it across the Channel, being derived from the French *tailler,* to cut, the *tally-sticks* being cut and notched with a knife. A squared stick of hazel or alder was prepared, and the money account was notched on the edge, small notches representing pence; larger, shillings; still larger, pounds. The stick was then split longitudinally, so as to leave notch-marks on each portion; one part was laid away in the exchequer strong room, the other was given to the creditor of the government. When the person came for payment, his portion of the stick was laid against that in possession of the exchequer, and if they *tallied* the claim was admitted, perhaps paid.

This system survived the introduction of Arabic numerals into England about 670 years. In 1826 the time came for the venerable system to abdicate in favor of the other Oriental method which had been asserting itself for so long. The pile of sticks, in companies, regiments, and brigades, that had by this time accumulated was something terrific. The question was, How to get rid of them? Prescriptive custom would prevent their being issued to the poor, or sold to bake the bread of the people, as the Alexandrian library heated the baths of that imperial city; so one fine day in 1834 they were to be privately burnt. A stove in the House of Lords was selected as a proper place for the incremation of another relic of the past; the wainscoting of the chamber protested by catching fire, the House of Lords set fire to the House of Commons, and both were burnt to the ground, — a grand funeral-pile.

The bakers insisted for some years in keeping tally-stick record of loaves purchased by their customers; some of us recollect it.

The oldest surviving treatises on mathematics are by the famous Alexandrians, Euclid, about B. C. 300; Ptolemy, A. D. 130; and Diophantus, A. D. 156.

Decimal fractions were invented 1482.

The first work on arithmetic published in England was by Tonstall, Bishop of London, 1522. The Italians had been in that field many years before.

(*Architecture.*) The crown member of the capital of a column.

Ab′a-ka. A fiber from which Manilla-rope is made. Ropes and cables of this material float in sea-water.

Ab′a-mu′rus. A buttress or second wall, built to strengthen another.

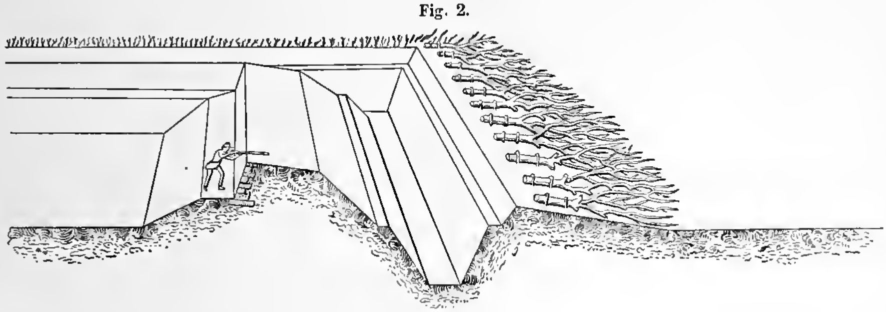
Ab′ap-tis′ton. (*Surgical.*) A trepan saw.

Ab′at-jour′. (*Building.*) A skylight, or aperture for the admission of light.

Ab′at-voix′. A sounding-board over a pulpit or rostrum.

Ab′at-tis. (*Fortification.*) An obstacle employed in military operations for delaying the approach of an enemy and keeping him under fire as long as possible. It is formed of trees or large limbs having the branches under two inches in diameter chopped off, the larger ones being sharpened and interlaced, and pointed toward the enemy. The butt ends

Fig. 2.



Abattis.

are secured by pickets, and may be partially embedded in the earth to prevent them from being readily removed.

Abattis are usually placed in front of the ditch in field fortifications, but they may be placed in the ditch against the counterscarp; in the former case they should be protected from the enemy's fire by a small glacis.

In a wooded country an abattis is readily formed by felling the trees in such a way that their branches shall interlace, leaving the trunk connected to the stump by a portion not cut; the stump should be high enough to protect a man behind it.

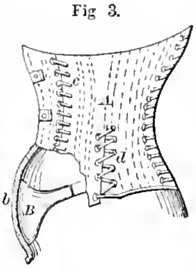
A small parapet formed of logs and backed by earth may be thrown up in the rear of the abattis, which thus constitutes a very efficient and available means of defence.

The abattis is referred to by Herodotus, Thucydides, and Xenophon, and was a common military defence derived from savage life. An abattis of thorny shrubs or limbs is the usual defence of an African *Kraal* against predatory beasts.

Abb. (*Weaving.*) Yarn for the warp.

Ab-dom′i-nal Sup-port′er. A bandage for the compression of the relaxed abdominal walls, intended to assist the muscles in holding the viscera in place. The simplest are made of elastic rubber covered with silk or cotton; they encircle the body from the navel to the pubes. Others are made of two steel springs passing over the crests of the pelvic bones, with a small pad resting on either side of the spine, and a large frontal one; their position and action being similar to that of a person holding his abdomen with both hands. They are of various patterns and designs; are used in cases of obesity, before and after parturition, and sometimes in cases of umbilical hernia.

Fig 3.



Abdominal Supporter.

Moody's Supporter, 1864, has a corset A, with lacings *c d b* and air-bag B secured by elastic plates *b* to the stays. The pad acts as an elastic truss.

There are various forms, patented and otherwise.

A-bee′. (*Fabric.*) A woven stuff of wool and cotton made in Aleppo.

A-beam′. Opposite the center of the ship's side; as, "the wind is *abeam*."

Ab′e-run′ca-tor. A weeding-machine.

A-bout′-sledge. The largest hammer used by blacksmiths; wielded by the helper, *turn-about* with the smaller hammer of the blacksmith himself.

A-bra′dant. A material, generally in powder, for grinding. The term includes emery, sand, glass, and many other materials. Laps, glaziers, rifles, paper, etc. are armed with abradants. See EMERY; and GRINDING AND POLISHING MATERIALS.

A-breu-voir′. (*Architecture.*) The mortar-joint or interstice between two voussoirs of an arch or the stones of a wall.

A′brid. A brushing-plate around a hole in which a pintle works.

Ab-sorb′ing-well. A well or shaft, dug, bored, or driven through a retentive stratum to allow surface or spring water to pass to a porous stratum below the former, so as to form an outlet for drainage.

Such wells are made at discretion in England, but in France are regarded with jealousy, and their use is only permitted after an examination and report by experts as to their possible effect upon watercourses, drainage or irrigation of other properties, etc.

In the United States they are but little used, and are not under public regulation.

Absorbing-wells are known as *dead wells* in the South of England; they are made in the gravel, the upper portion being close-steened work and the lower open-steened work. The bottom is unpaved, to allow the water to infiltrate.

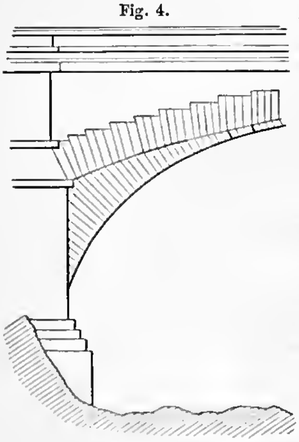
A-but′ting-joint. (*Carpentry.*) A joint in which the fibers of one piece are perpendicular to those of the other.

(*Machinery.*) A joint in which the pieces meet at a right angle.

A-but′ment. A fixed point or surface, affording a relatively immovable object against which a body *abuts* or presses while resisting or moving in the contrary direction. See PIER; SKEWBACK.

1. (*Building.*) A structure which receives the lateral thrust of an arch. The abutment may be a pier or wing walls forming a horizontal arch; or the arch may be continued to a piled or hewn foundation, which is then the *abutment.*

Fig. 4.



Pier Abutment.

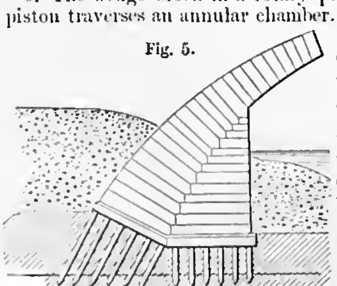
2. (*Machinery.*) A solid or stationary surface against which a fluid reacts.

a. The wedge which lifts the piston of one form of rotary steam-engine, and which forms a surface for the steam to react against as it presses the piston forward in its circular path.

b. The wedge block in a rotary pump, where the piston traverses an annular chamber.

c. One of the cylinder heads of a steam-engine, receiving the back pressure of the steam which is made effective upon the piston.

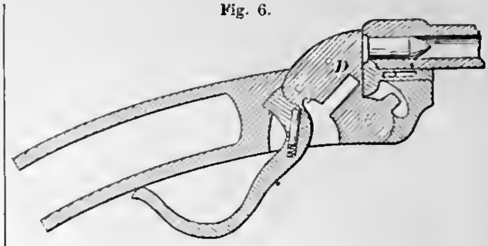
Fig. 5.



Piled Abutment.

3. (*Carpentry.*) The junction of two pieces of timber, where the grain of one is at a right angle to that of the other, or nearly so.

Fig. 6.

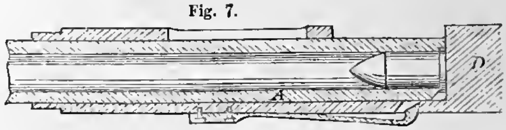


Movable Abutment.

4. (*Fire-arms.*) The block at the rear of the barrel of a fire-arm (especially a breech-loader), which receives the rearward force of the charge in firing.

It has the function of the *breech-plug* or *breech-pin* in the muzzle-loading fire-arm.

Fig. 7.



Stationary Abutment.

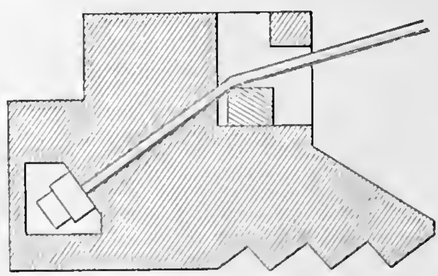
A similar term is applied to the corresponding portion in breech-loading cannon.

In Fig. 6, the *abutment* D is movable upon an axis so as to expose the rear of the bore for the insertion of the cartridge.

In Fig. 7, the *abutment* D is stationary, relatively to the stock, and the barrel slips away from the abutment to allow the insertion of the cartridge. The variations in the arrangement are very numerous, and the different devices form the subjects of numerous patents in the United States and foreign countries. See FIRE-ARM; BREECH-LOADING.

5. (*Suspension Bridge.*) The masonry or natural rock in and to which the ends of a suspension cable are anchored.

Fig 8.



Suspension Bridge Abutment

6. (*Hydraulic Engineering.*) A dam is in some sense an abutment, as it sustains the lateral thrust of water. See DAM.

A-but′ment Arch. An end arch of a bridge.

A-can′tha-lus; A′can-tha′bo-lus. An instrument for extracting thorns or splinters from a wound.

Ac-cel′er-a′tor. 1. A light van used in England for conveying mails between post-offices and railway-stations, etc.

2. A cannon, with several powder chambers, whose charges are exploded consecutively, in order to give a constantly increasing rate of progression to the projectile as it passes along the bore.

Ac′cent-ed Let′ters. Vowels having signs above them (or below, in the case of the cedilla "ç") to indicate a specific pronunciation ; as : —

Acute,	á	Diæresis,	ä
Grave,	à	Long,	ā
Circumflex,	â	Short,	ă

Ac-cip′i-ter. (*Surgery.*) A bandage applied over the nose ; so called from its likeness to the claw of a hawk.

Ac-com′mo-da′tion Lad′der. (*Nautical.*) A ladder suspended at the side of a vessel to facilitate the passage to and from the boats alongside.

Side ladders and stern ladders hang from these parts of a ship.

Ac-cor′de-on. A *free-reed* instrument introduced into England from Germany about 1828. The exterior form of this instrument is a parallelopiped. The action consists of a bank of vibrating reeds or tongues which are operated by the bellows. Keys open the air-ducts to the respective reeds as the bellows are expanded and contracted. Dampers are attached to the end, which is grasped by the left hand, while the other end is furnished with keys by which the notes are sounded by the fingers of the other hand.

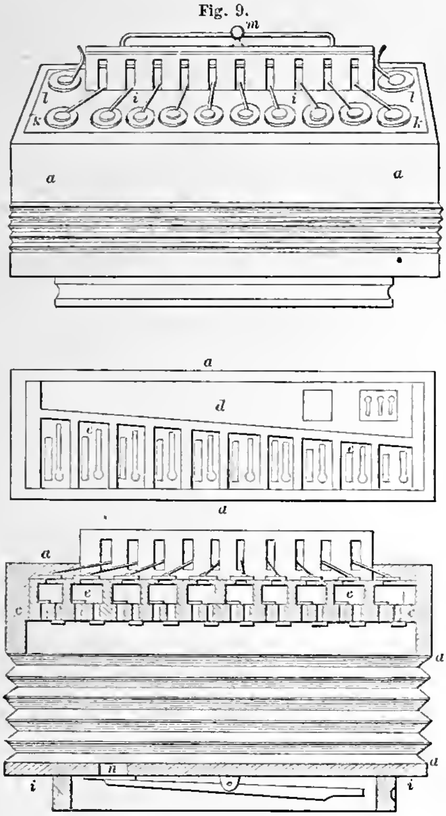
The concertina is an improved form of the accordeon.

A common form of the accordeon is shown in the engraving, which affords three views : —

A general exterior view ;

A sectional view in the plane of the key-board, and exhibiting the separate wind-cells ;

Fig. 9.



Accordeon.

A sectional view at right angles to the latter, and exhibiting the parts concerned in the course of the air, — damper, bellows, ducts, and cells.

a a is a rectangular box, the lower portion of which is of air-tight flexible material forming the bellows and wind-chest ; *c* is a partition forming the top side of the wind-chest, and the lower surface of the large cell *d*, and the ten smaller cells *e e*. In the bottom of each cell are two apertures cut through the partition *c* ; each of these apertures is covered on one side by a thin metallic plate, which has a long rectangular opening in which a free reed plays as the air passes through the opening when the bellows is in action, and the appropriate key is lifted. See Free Reed.

On the side of each aperture, opposite to that occupied by the reed, is a flap or valve of thin leather, cemented by an edge to the partition *c*. The reeds of each cell are fixed one to the upper side of the partition and the other to the lower side ; the reed above the partition is sounded when the bellows is extended, and that below the partition when the bellows is collapsed ; the flap of leather, in each case, prevents the sounding of the reed when the wind goes in a direction contrary to that described.

The large cell *d* has also apertures, which are provided with reeds and valves at the respective ends of the apertures, as just described. The plates of these reeds have two or three tongues of greater size and lower tone, forming a base which chords with the other notes by which the air is played.

The tops of the cells *e e d*, or the partition *c*, are covered with buff leather, against which the under side of the cover *i i* slides when it is pushed into closed position.

In the cover, over each of the small cells, is a hole closed by a key *k*, and over the large cell *d* are two holes, one at each end, closed by the keys *l l*, which are moved simultaneously by the knob *m*. The valve *n*, at the bottom of the wind-chest, forms a damper by which the bellows may be extended or contracted, when required, without sounding a note.

Several notes may be sounded together, and, the reed of each small cell being different, the compass is equal, tones and semi-tones being counted, to the number of reeds.

The accordeon differs from the melodeon more in size and the mode of manipulation than in principle. The latter will be considered by itself, but may be stated to be of such size as to constitute a piece of standing furniture, having its keys in a bank, like a piano, and foot-pedals for the generation of wind, by which the reeds are vibrated as the action of the keys opens the corresponding valves. The same instrument is known in England as the harmonium, and has been known at various times by the names of seraphine, æolophon, symphonium.

Faas, June 13, 1854, combines, with the diatonic scale of the large keys, two other scales, viz., one for producing all the intermediate notes or semitones, and the other founded upon the subdominant of the diatonic scale ; both arranged so as to be fringed by a single set of small keys, to enable the performer to produce harmony in any key. The valves of the lower, or small, keys stop two series of apertures opening from the wind-chest below. The two series of apertures are alternately opened and closed by means of a wind-stop, with two rows of apertures arranged in alternate order. These are governed by levers jointed to the wind-stop and to one another.

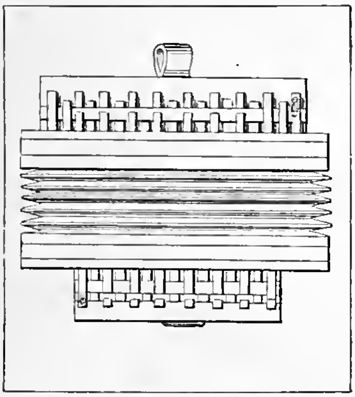
A sounding-board gives strength and resonance to the tones, and allows space for the described arrangement of the valves.

FAAS, August 12, 1856. Immediately beneath the perforated board through whose openings the air enters, is a thin sliding board with corresponding apertures. By means of a handle the operator adjusts the position of the board so as to vary the strength of the tones by regulating the quantity of air admitted to the reeds. Double keys close the apertures of the base reeds, the smaller keys covering holes through the larger ones, by which arrangement an entire octave of base notes is produced.

ZIMMERMAN, July 10, 1866, has certain distinguishing keys between the consecutive octaves, which give the same tone in either inflating or compressing the wind-chest.

PRIES, June 21, 1864. The accordeon is so constructed as to admit of its being played in any key, to accompany an orchestra; this is accomplished by arranging double key-boards, one on each side of the instrument, which admit the additional number of keys, conveniently arranged for the additional reeds necessary for the purpose. The keys in the respective banks of each end represent octaves, and the respective ends represent different chromatic scales.

Fig. 10.



Pries's Accordeon.

The instrument is called by the inventor an *orchestron*, and the banks of keys are placed at an angle with the side, so as to present the keys more conveniently to the fingers of the performer.

Ac-coup'le-ment. (*Carpentry.*) A timber tie or brace.

Ac-cou'ter-ments. (*Military.*) The devices by which a soldier carries his arms, ammunition, etc. These vary in the different arms of the service, according to the exigencies of the case.

Those for infantry consist of a cartridge-box and plate, cartridge-box belt and plate, waist-belt and plate, gun-sling, bayonet-scabbard, and cap-pouch; to which, on a march, are added the knapsack, canteen, and haversack.

The infantry cartridge-box is made of black bridle-leather, with an outer flap which turns over, covering the top, and is fastened by a short strap to a brass button; inside of this is a lighter leathern cover to protect the ammunition when, as in action, the outer flap is necessarily left unfastened. A brass plate is generally affixed to the flap, but is not essential, being rather ornamental than useful. In the interior of the box are two tins, each having an upper and a lower compartment, the former being divided into two parts, one containing six and the other four loose cartridges, while a bundle of ten is placed in the lower compartment, which is open at the side; the box thus contains forty cartridges when filled. At the side is a small pocket, covered by a flap, for containing the implements, or "appendages," belonging to the musket, as the screw-driver and cone-wrench, wiper, ball-screw, spring-vice, and tumbler-punch.

Two loops are attached to the back for the passage of the cartridge-box belt, which passes diagonally across the body in front and rear from the left shoulder to the right side, where it passes beneath the waist-belt and is secured to the cartridge-box by two buckles. For ornament a round brass plate (in the United States service stamped with an eagle) is attached to this belt so as to fall about the centre of the chest of the wearer. The waist-belt, as its name imports, passes around the waist, and carries the bayonet-scabbard and cap-pouch; it also serves to keep the cartridge-box and belt in place close to the body; it is fastened by a brass plate of oval shape, having two studs and a hook, the studs entering two holes in one end of the belt, which is drawn tight and the hook inserted in a hole at the other end.

The bayonet-scabbard is made of black bridle-leather; it is triangular in shape, to fit the bayonet, and has a brass ferrule at its bottom for ornament and protection; its length is 19½ inches; a leather loop, or *frog*, is attached to the upper part of the scabbard for inserting the waist-belt.

The cap-pouch is also made of black bridle-leather, and has a flap and inner cover, the flap being fastened by a brass button; the pouch is 3 inches in length and depth, and is lined with sheep-skin with the wool on, to prevent the caps from being jarred out and lost when the flap is not buttoned. A cone-pick, of steel wire, bent so as to form a ring at one end, is inserted in a loop in one corner of the cap-pouch.

The gun-sling is of russet bag-leather, 1¼ inches wide and 46 inches long; it has a standing loop at one end and a brass hook at the other, with a sliding loop between. For use it is passed through the guard-bow and middle-band swivels of the musket, the hooked end passed through the loops and inserted in one of a series of holes punched in the sling; the gun may then be slung across the back, leaving both hands free, or it may be suspended from any suitable object.

All belts in the United States land service are black, and are made either of leather or of a strong species of felting, called *buff*, probably because belts were formerly made of that color.

Until within a very few years a separate belt was used for suspending the bayonet-scabbard, passing over the left shoulder and crossing the cartridge-box belt diagonally on the breast, which was ornamented with a plate at the crossing; the intersection of these two white lines, particularly when relieved against the dark-blue ground of the uniform, rendered the soldier as perfect a target as a marksman need desire, the plate representing the "bull's eye."

The cartridge-box belt has sometimes been dispensed with, particularly for riflemen, the whole weight of the accouterments, with, in this case, the addition of a heavy sword-bayonet and scabbard, being borne by the waist-belt, which of course had to be drawn very tight, forcibly compressing the abdomen, and causing great and unnecessary fatigue or even permanent injury.

This arrangement was, we believe, generally condemned by medical men, and in fact by every one who thought on the subject; but as the weapon above mentioned was in very limited use, toward the close of the war especially, the evil was not so general as it might have been.

The cartridge-box for cavalry resembles in external appearance that for the infantry, but is smaller, and its two loops are arranged so as to pass the saber-belt through them. Those used by our troops during the late war were variously arranged in the interior to suit the supposed necessities of the cartridges of each particular kind of carbine, as Burnside's, Merrill's, etc., etc. That adapted for a paper cartridge, as Sharp's, of which a greater number was issued than of any other, appeared to answer very well for others, though, no doubt, for metallic cartridges a special box is better.

The cavalryman is also provided with a small box or pouch for revolver cartridges and a cap-pouch.

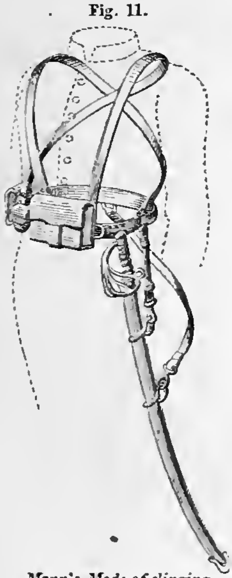
The saber-belt, to which all the preceding are attached, consists of a waist-belt, with two brass rings for the shoulder-strap and saber-slings, and a brass loop sewed at one end to receive the plate, which is rectangular and connects the two ends of the belt together. The shoulder-strap passes from a ring on the left side over the right shoulder, and returns, supporting the saber, which is suspended by two saber-slings passing from the brass ring at the waist-belt through two iron rings on the saber-scabbard, and buttoned.

The accouterments for horse artillery merely consist of a pistol cartridge-pouch and a cap-pouch, both similar to those above described, and a saber-belt which differs from the cavalry-belt only in the omission of the shoulder-strap.

A number of patents have been granted in the United States for improvements in the construction of, and in slinging accouterments. Since the commencement of the late war thirty-five patents have been granted in this branch of inventions. Attention has been directed to several points: —

First. The ease of the soldier in carrying his knapsack, etc. has been attempted to be secured: 1. By making one portion of his accouterments balance another, as in Mann's, Mizner's, and Wood's; 2. By a saddle-piece resting on the hips, as in Dickey's; 3. By suspension-hooks on the shoulders, as in Sweeney's; 4. By a frame reaching from the shoulders to the buttocks, as in Baxter's; 5. By modes of shifting the weight occasionally to vary the point of pressure and relieve the otherwise constant strain, as in Short's and Süs's.

Fig. 11.



Mann's Mode of slinging Accouterments.

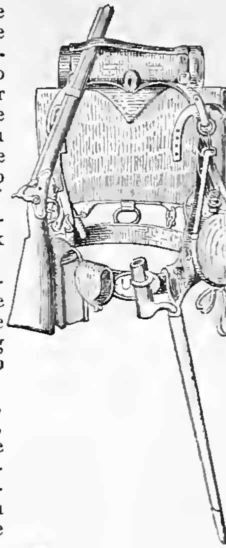
Secondly. In arrangements for making the knapsack do service as a shelter, couch, or mattress.

Thirdly. In devices for the more compact arrangement of the compartments of the knapsack, haversack, or cartridge-box to increase their utility, readiness for duty, and lightness.

The accompanying cuts will render it unnecessary to give a lengthened description, and the examples are placed in the order stated, founded on the similarities of purpose and means.

MANN, December 8, 1863. The cartridge-box is worn in front of the person, and acts as a counterbalance to the other accouterments, the weight of the whole being thrown upon the shoulders.

Fig. 12.



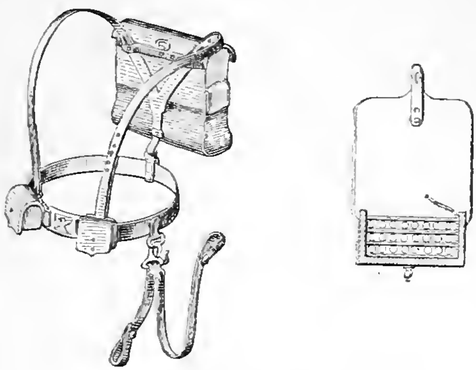
Wood's Mode of slinging Accouterments.

WOOD, May 15, 1866. The devices refer to the means for slinging the gun, bayonet, cartridge-box, and canteen so as to counterpoise each other and the knapsack. The gun is hung to hooks on the strap. A hook on the cartridge-box adapts it to be attached to any part of the equipment. The bayonet is also slung by a hook on its scabbard.

When the accouterments are shifted to the rear, the hind side of the belt is connected to a ring beneath the knapsack, to help sustain the belt.

MIZNER, January 16, 1866. The haversack, which is carried on the shoulders, forms a counterpoise for the cartridge-boxes, which are worn on the front of the belt; the upper portion of the divisional haversack is occupied by boxes, to contain three days' meat, coffee, sugar, and salt, in separate cases; the lower or bag-like portion being adapted to contain an equivalent quantity of bread. A strap pass-

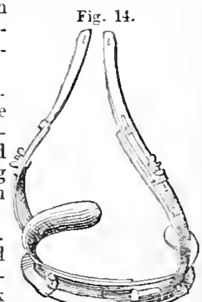
Fig. 13.



Mizner's Cavalry Accouterments.

ing along the bottom and up one end of the cartridge-box affords the means for elevating the packages of cartridges, which fit closely therein, and are difficult of removal by the fingers.

Fig. 14.

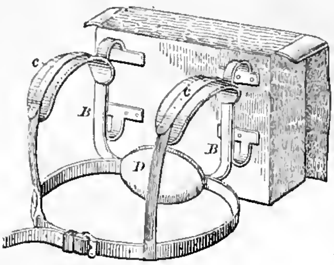


Dickey's Knapsack Supporter.

DICKEY, March 21, 1865. To relieve the soldier of the backward pulling of the knapsack it is partially supported by adjustable standards rising from a saddle-piece, which rests upon the hips.

SWEENEY, February 4, 1862. The knapsack is so suspended that an air space may intervene between it and the back of the soldier. The curved pads *c* rest upon the shoulder,

Fig. 15.

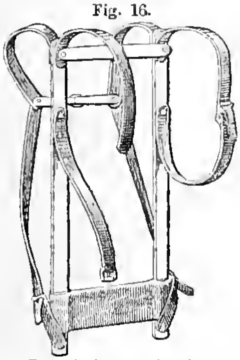


Sweeney's Knapsack.

and the bars *B* descend therefrom to the back plate *D*. The knapsack is secured by plates to these parts, and rigidly held at a distance from the back.

BAXTER, March 17, 1863. This improvement is intended to prevent the pressure of the knapsack upon the small of the back and the cramping of the movement of the arms, and it consists in supporting the sack by strips of wood extending from the shoulder to the hips; also in securing the chest-straps so as to leave the arms free.

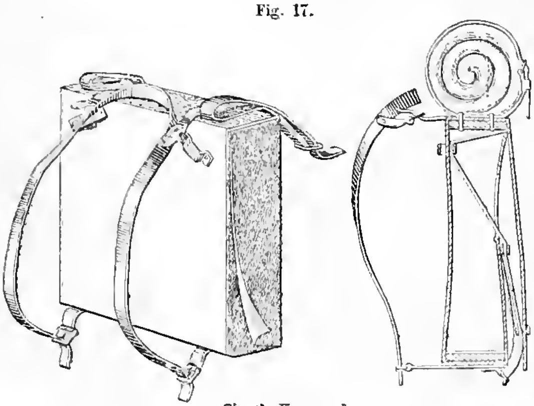
Fig. 16.



Baxter's Knapsack Sling.

SHORT, January 28, 1862; December 14, 1862. The mode of slinging the knapsack permits it to be loosened so as to fall away from the shoulders and spine of the wearer, as a means of shifting the weight and pressure, and allowing circulation of air against the back of the person. The arrangement also permits it to be raised

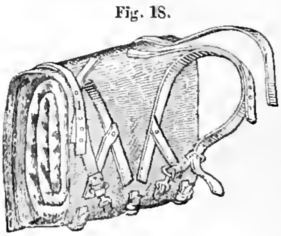
Fig. 17.



Short's Knapsack.

or lowered in a vertical line according to the convenience of the soldier. The neck and shoulder strap is connected to the upper part of the knapsack by intermediate straps, and the lower part of the same is designed to prevent lateral swaying during quick movements.

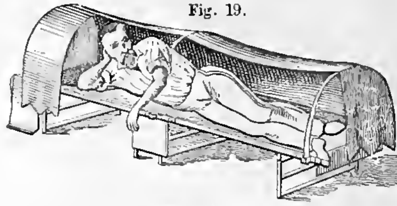
Fig. 18.



S s's Knapsack.

Süs, May 17, 1864. This invention consists in the employment of a pair of suspending straps which pass over the

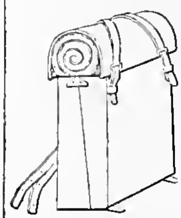
Fig. 19.



Weber's Knapsack.

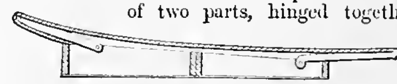
shoulder in connection with another shorter pair of straps attached to the top of the knapsack near its center, and also a pair of straps attached, one to each end of the knapsack, for the purpose of varying the position and shifting the weight of the same when desirable.

Fig. 20.



WEBER, January 31, 1865. The frame of the knapsack is capable of being changed into a couch, and the cover forms a shelter. The central section has jointed and folding sides.

RUSH, March 25, 862. The frame of the knapsack is made of two parts, hinged together.



Rush's Knapsack.

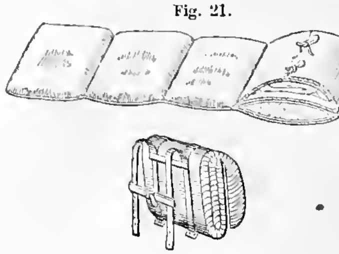
At the thick end of one part are pivoted two arms, which, when thrown out, rest upon the edge of the knapsack, and serve to hold the canvas for forming a bed.

FRODSHAM AND LEVETT, October 1, 1861. This invention consists of an india-rubber casing made water-tight and containing a bag of finely cut cork or other filling, thus forming a life-preserver. A pocket is made in the rubber casing to contain articles of clothing, thus forming a knapsack, which when unrolled becomes a bed, the contained articles forming a pillow.

MIZNER, November 27, 1866. The knapsack is combined with a haversack. The straps that secure the parts of the sack together, when packed and folded, are not sewed to the material, but are riveted to each other, and also to the sling-straps. The latter pass from the knapsack over the shoulders, beneath the armpits, and unite behind the back.

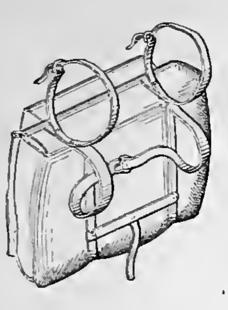
McEVOY, January 7, 1862. The body is

Fig. 21.



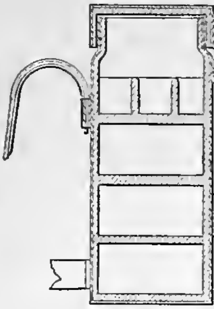
Frodsham and Levett's Knapsack.

Fig. 22.



Mizner's Knapsack.

Fig. 23.

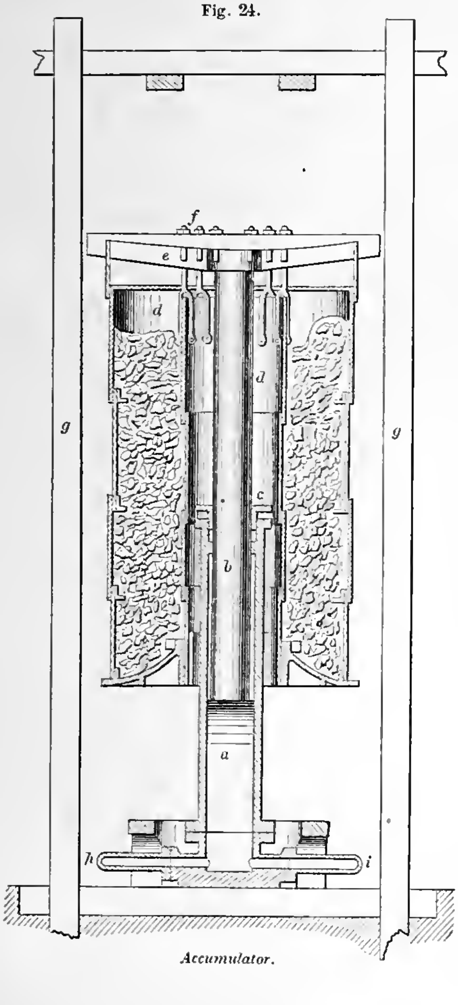


McEvoy's Knapsack.

made of wicker-work, and has partitions and doors; it is covered with waterproof material, and contains medicines, lint, bandages, splints, and surgical instruments. It is designed to be carried by the surgeon's orderly in an engagement or during field duty.

Ac-cu'mu-la tor. An india-rubber spring which accumulates lifting force, and is applied to many

Fig. 24.



Accumulator.

specific purposes on board ship, in machine-shops, etc.

An apparatus used in working hydraulic cranes and other machines where a steady and powerful pressure of water is required. The accumulator is intended as a substitute for a natural head, as being more compact. Sir William Armstrong, in the first applications he made of this principle to hydraulic cranes, employed a *natural* head of water as the motive agent, obtaining the same by pumping water into tanks at an elevation of about 200 feet; but subsequently he has always employed the *accumulator*, as offering the advantages of greatly increased capacity for pressure, and a less prime cost of erection. The accumulator is shown in Fig. 24; it consists of the large cast-iron cylinder *a*, fitted with the plunger *b*, which works water-tight by means of the gland *c*, and packing. To this plunger is attached, by means of the bolts *f*, and strong cast-iron cross-head *e*, the loaded weight-case *d*. Thus a pressure is obtained upon the water in the cylinder, equal to a column of water 1500 feet high, or 660 lbs. upon the square inch. As the water is pumped into the cylinder by the pumping engines through the pipe *h*, the piston, with the weighted case, rises, being guided by the strong wooden framework *g*, and is made to regulate the amount of water pumped in, by actuating a throttle-valve in the steam-pipe of the pumping engine, which it closes after having reached a certain height. When the cranes, etc. are in operation, the water passes from this cylinder through the pipe *i*, to those actuating the motion of the cranes, and the weighted plunger naturally descends, always keeping up a constant pressure upon the water; in descending, the same causes the throttle-valve to open again, and the water is again pumped in.

A'ces. (*Nautical.*) Hooks for the chains.

A-cet'i-fi-er. An apparatus for exposing cider, wort, or other wash to the air to hasten the acetification of the fermented liquor. See GRADUATOR.

Ac'e-tim'e-ter. See ACIDIMETER.

Ac'e-tom'e-ter. A hydrometer suitably graduated for ascertaining the strength of acetic acid and vinegar.

Ach'ro-mat'ic Con-dens'er. An achromatic lens or combination used to concentrate rays upon an object in a microscope. See *Carpenter on the Microscope*, pp. 117–119, ed. 1857.

Ach'ro-mat'ic Lens. Achromatic, literally colorless, lenses were first introduced by John Dollond, of London, about the year 1758. Ever since the invention of the telescope it had been a desideratum with astronomers and opticians to obtain a lens which would give a perfect image free from color with a moderate focal length, it having been found by experience that it was necessary to increase the length of focus of the object-glasses of telescopes in the proportion of the square of the magnifying power desired, to obtain distinct vision. This was owing in part to the distortion or spherical aberration, caused by the rays striking the lens at greater or less distances from its center, being refracted at different angles in proportion to the greater or less convexity of the lens, and converging to different foci more or less distant from the latter; but principally to the dispersion or decomposition of the light, as in prisms, to two of which, joined at their bases, the lens is in fact equivalent. See PRISM.

This fringed or colored appearance may be observed about the margin of almost any object viewed through a lens of short focal length, such as an ordinary microscope.

The excessive length which had to be given to refracting telescopes in order to obtain what is now considered a very moderate magnifying power, 100 feet for a power of 200, led Gregory and Newton to the construction of reflecting telescopes (see TELESCOPE), and these for many years were almost the only kind in use. The dispersion of light, or the length of the spectrum formed by prisms having the same refracting angle, varies greatly in different substances though their refracting powers may be equal or nearly so.

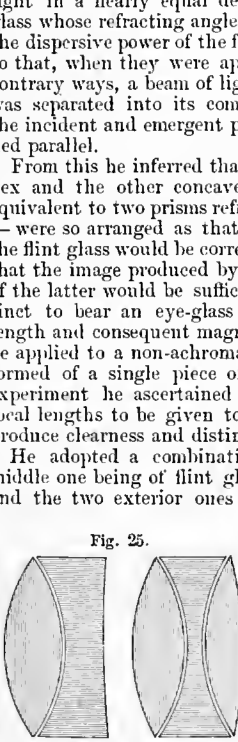
Newton had supposed that the dispersion was always proportional to the refraction, and it was in the course of a series of experiments undertaken in order to verify this theory of Newton, which had been controverted, that Dollond was led to his discovery.

He found that a prism of white flint glass whose refracting angle was about 25 degrees refracted the light in a nearly equal degree with one of crown glass whose refracting angle was 29 degrees, but that the dispersive power of the former was much greater; so that, when they were applied together to refract contrary ways, a beam of light passed through them was separated into its component colors, although the incident and emergent parts of the beam continued parallel.

From this he inferred that if two lenses, one convex and the other concave, — which are in effect equivalent to two prisms refracting in different ways, — were so arranged as that the dispersive power of the flint glass would be corrected by the crown glass, that the image produced by the excess of refraction of the latter would be sufficiently colorless and distinct to bear an eye-glass of much shorter focal length and consequent magnifying power than could be applied to a non-achromatic, double-convex lens, formed of a single piece of glass; and by further experiment he ascertained the most advantageous focal lengths to be given to each glass in order to produce clearness and distinctness.

He adopted a combination of three lenses, the middle one being of flint glass and double concave, and the two exterior ones of crown glass, double convex, believing that it produced better results and more effectually corrected the spherical aberration; the combination of two glasses is now, however, universally adopted.

Fig. 25.



Achromatic Lenses.

It has been proposed to use metallic solutions and other liquids which have a higher dispersive power than flint glass, enclosed in glass disks of the proper curvature hermetically sealed at their edges, in place of that article for the concave lens, but though several of these substances appear to have given excellent results experimentally, they have never been brought into general use.

On account of the difficulty of obtaining a good article of flint glass, more particularly, and the trouble and skill required in grinding and polishing the faces of each piece so that they may have the proper curvature and fit accurately together, achromatic lenses have always been and will probably continue to be very expensive, especially the larger sizes. Dr. Dick mentions one of 5½ inches aperture and 5½ feet focal length, which cost 200 guineas.

Plöpl, an optician of Vienna, has recently invented an improvement on the achromatic, which he calls the dialytic telescope, in which the several different kinds of glass composing the compound object-glass are not placed close together, but at regulated distances apart. This arrangement allows a shortening of the tube.

Chester More Hall, of Essex, England, invented the achromatic telescope in 1729, but did not make it public. Dollond had to invent it over again.

Ac'id-im'e-ter. An instrument for determining the purity or strength of acids, founded on the principle that the strength of any sample of acid is proportionate to the quantity of alkali which it will neutralize, or the quantity of carbonic acid gas which it disengages from a carbonate of soda or potash. An accurate and economical apparatus for this purpose is proposed by Dr. Ure, as follows: a graduated glass cylinder, having a discharge tube and capable of containing 10,000 grains of distilled water, is attached by a flexible tube to a Florence flask containing a supersaturated solution of carbonate of soda or potash, in which is a test-tube containing a sufficient proportion of acid by weight to evolve carbonic acid gas equal in volume to the contents of the cylinder. Bicarbonate of soda is preferred, as one equivalent of any acid disengages from it two equivalents of carbonic acid gas, and the quantities of various acids required to evolve a volume of gas equal to 10,000 grains of distilled water are as follows: —

Anhydrous sulphuric acid,	16.80	grains.
Oil of vitriol,	20.58	"
Anhydrous nitric acid,	22.67	"
" hydrochloric acid,	15.33	"
" acetic acid,	21.42	"
Crystallized citric acid,	80.64	"
" tartaric acid,	63.00	"

By tilting the flask the test-tube is upset and the acid brought in contact with the alkaline solution, liberating the carbonic acid gas, which passes over into the cylinder, displacing a bulk of water equal to that of the gas evolved, the amount of which is shown by the graduations on the side of the cylinder. This indicates the strength of the acid. For example, if the water should be depressed to the mark 50 on the cylinder, it shows that the sample contains but fifty per cent of pure acid. This apparatus is the converse of the *alkalimeter*, which see.

A-cis'cu-lis. A small mason's pick, with a flat face and pointed peen.

A-cock'bill. 1. The situation of the yards when they are topped up, at an angle with the deck.

2. The situation of an anchor when it hangs from the cat-head by the ring only.

A-cou'me-ter. An instrument invented by Itard for measuring the degree or extent of hearing.

A-cous'tic In'stru-ments. Instruments or apparatus pertaining to the ears, the perception, measurement, or projection of sound.

I. Those appertaining to the ear are, — 1. *Prosthetic.* 2. For *exploration.* 3. For *operation.*

1. Of the *prosthetic* are the
   - Auricle.
   - Cane Trumpet.
   - Cornet.
   - Conversation Tube.
   - Ear; Artificial.
   - Ear of Dionysius.
   - Ear Trumpet.
   - Sonifer.
   - Tympanum; Artificial.
2. *Exploration.*
   - Acoumeter.
   - Ear Speculum.
   - Otoscope.

3. *Operation.*
Ear Spoon.
Ear Syringe.
Eustachian Tube Instrument.
Meatus Knife.
Organic Vibrator.

II. Instruments for making or conveying audible sounds.

(Not including those of a prosthetic nature cited in Class I.)
Acoustic Telegraph.
Air pipe.
Alarms. (*Varieties;* see ALARMS.)
Musical Instruments. (*Varieties,* see MUSICAL INSTRUMENTS.)
Speaking Trumpet.
Speaking Tube.
Steam Whistle.

III. Instruments for measuring the quality of sound, the extent of hearing, the number of vibrations in a given time, etc.
Acoumeter.
Kaleidophone.
Metronome.
Sirene.
Sonometer.
Tonometer.

IV. Auscultation Instruments.
Percussor.
Pleximeter.
Stethometer.
Stethoscope.

(See the above in their alphabetical order.)

A-cous'tic Tel'e-graph. A telegraph making audible instead of visual signals.

In this sense — the most general — every *sounder* may be included in the class, for it is capable of being, and is, used to convey information by an arrangement of repetitive blows and intervals.

The present common use of the Morse instrument brings it within this category, the signals being read by ear rather than by consulting the paper ribbon.

The speaking-tube may be considered another form, conducting a puff of air to the other end, where it operates a whistle, or the sound is recognizable as an audible expression.

Bright's (English Patent) is adapted to communicate phonetic signals. It consists of an axle having a magnet and double arm; the magnet, when acted upon by electro-magnetic coils, causes the axle to vibrate or deflect in one direction, thus sounding a bell by means of a hammer-head on one arm; the subsequent reversal of the electric current causes a muffler on the other arm to stop the sound.

In a more perfect form, Bright's Acoustic Telegraph consists of a hammer in connection with a lever, which is acted upon by every polarization of a set of electro-magnets by the local current, and thereupon strikes a small bell. A pair of these bells are connected to each wire; one bell is struck by the passage of the positive, and the other of the negative current, the alphabet being readily formed by the difference in their tones and the number of beats.

Another form of audible telegraph consists of a wire which is tapped and conducts the sound to a resonant diaphragm.

Wilson's Patents, 1866, refer to the production of a musical note by the action of a valve governed by the electro-magnetic current. The sound is continuous or intermittent, and variable in tone or pitch, as may be required.

Ac'ro-ter. A small pedestal placed on a pediment and serving to support a statue

Ac-tin'o-graph. An instrument for registering the variation of the chemical intensity of the sun's rays. As contrived by Mr. Hunt, it consists of a fixed cylinder on which is placed a prepared photographic paper covered by a revolving cylinder having a triangular opening divided by bars through which the direct rays of the sun pass; their effect upon the paper indicates their chemical intensity at different times.

Ac'ti-nom'e-ter. An instrument for measuring the power of the sun's rays, invented by Sir J. F. W. Herschel about 1825. A hollow cylinder of glass filled with a colored liquid is soldered to a thermometer-tube blown into a ball at the upper end; being exposed alternately to the sun's rays and removed to the shade, a comparison of the differences of expansion of the liquid indicates the relative intensity of the solar radiation.

The discovery of the presence of another principle, associated with the light and heat derived from the sun, seems to have been made some years ago by Mr. R. Hunt in England.

Sir J. Herschel proposed to establish, as a unit for the intensity of solar heat, that value which would, in a minute of time, dissolve a thickness equal to one-millionth part of a meter of a horizontal sheet of ice, when the sun's light falls vertically upon it. This he calls an *actine,* and from experiments made by him at the Cape of Good Hope he determined the value of a degree on the scale of one of his *actinometers* to be equivalent to 6.093 *actines.*

The actinometer is useful in determining the quantity of solar heat which is absorbed in passing through the different strata of the atmosphere, for which purpose the observations must be made at stations differently elevated above the level of the earth or sea. It may also be employed to determine the diminution of heat which takes place during eclipses of the sun.

See *Manual of Scientific Inquiry,* published by the English Board of Admiralty.

One form of *actinometer* is sometimes called a photometer. The former name indicates that its purpose is to determine the *actinic* power of the solar rays, while the latter name indicates a measurer of the *intensity* of the light.

One use of the actinometer is to ascertain the proper time for exposing a plate in the camera, or a sensitized paper in the printing-frame. The box has a spring bottom and a glass and wooden cover. On the under side of the glass are secured a series of thin strips of paper arranged in layers so that each layer projects over the edge of the strip above it, thus producing a graduated semi-transparent medium. The number of layers of any particular point is indicated by black figures on the lowest strips of paper. Upon this false bottom is spread a series of strips of paper rendered sensitive by saturating with alkaline chromate. The apparatus is then exposed to the light, and the strips of sensitive paper will be successively darkened according to the depth of over-lying paper. See PHOTOMETER.

Ac'tion. An exertion, applied in machinery to an effective motion; as, —

A *single* action; illustrated in the ordinary lift-pump, the atmospheric engine, etc.

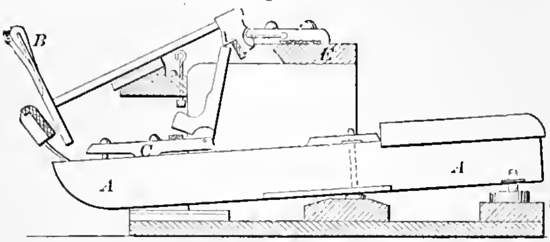
A *double* action, in which the go and return motions are each made effective or are positively effected by the motor; as the double-acting pump, throwing a stream at each course of the piston; the ordinary high-pressure steam-engine, in which the piston is driven each way by the force of stream.

(*Music.*) The *movements* or working parts of a stringed or wind instrument, which is operated by a key-board; such as an organ, piano-forte, melodeon, etc.

It includes the portion between the keys and the strings, — the portion engaged in *striking* and *damping*.

The *actions* are known, by a peculiarity in the instrument, as *grand, square, piccolo, single, double, upright* actions; or from the inventors, as Broadwood's, Collard's, Erard's, Steinway's, etc. See PIANO-FORTE.

Fig. 26.



Piano-Forte Action

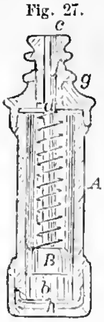
A is the key; *B*, the hammer which falls back upon the *check*, and a bar mid length of the stock, called the *hammer-rail*. *C* is an adjustable bar on which is mounted the *jack*, whereby the hammer is actuated. *E* is the rail to which the hammer is hinged.

Ac′u-punct′u-ra′tor. Derived from *acus* (Lat.), a needle. An acicular instrument for treating certain complaints, such as headaches, lethargies, etc. It is of great antiquity in the East, and of late years it has been introduced somewhat extensively into Europe and the United States. The essential apparatus employed is simply a set of needles set in a handle, or detached needles, which by a slight rotary movement are passed to the required depth beneath the tissues and allowed to remain for a length of time varying from a few minutes to an hour.

In the sixteenth century, according to Jerome Cardan, the practitioners of this art travelled from place to place, and rubbed their needles with a magnet or substance which they pretended rendered their insertion painless. Without any such application, however, the punctures are so minute that pain is not felt after the first insertion of the needle.

The needles are sometimes used for conducting the galvanic current to parts at some distance beneath the surface of the skin, and are sometimes made hollow for the injection of a sedative into the tissues, for the relief of neuralgic affections. This latter mode of application was suggested by Dr. Alexander Wood of Edinburgh, Scotland. See ANÆSTHETIC APPARATUS.

Fig. 27.



Klee's Acupuncturator.

It is sometimes called a *Dermopathic* or *Irritation Instrument*, and is used to introduce a vesicatory liquid beneath the epidermis.

FIRMENICH'S instrument, March 18, 1862, may be considered a type of its class. The piston containing the needles is adjustable in its cylinder, which holds the medicinal preparation. The needles project through the diaphragm to the required extent, and the epispastic liquid insinuates itself along with the needles into the punctures.

KLEE'S acupuncturator, June 19, 1866, has a regulating nut *g*, to adjust the depth of penetration of the needles which project through the diaphragm to conduct the liquid from the cylinder *A* and introduce it through the skin. The needles *b* are stocked in the piston *B*, whose stem *d* is sleeved in the stem-screw *c f*.

In Oriental countries the needles are made of gold or silver. In China their manufacture is regulated by law. They are of different sizes, some about four inches in length and having spiral handles to facilitate their rotation after insertion. They are driven in by a small, lead-loaded hammer with a leathern face. Their use is very common in China and Japan, and was communicated to Europe by the physician to the Dutch Embassy in the seventeenth century. It was revived in France in 1810. The English needles are long, made of steel, and have knobbed heads to facilitate turning after introduction. The tendency here, judging by the patents, is to have the needles in clusters.

The operation is well performed by a tubular needle connected with a syringe, by which a weak solution of morphia is injected into a diseased tissue, producing local anæsthesia. See ANÆSTHETIC INSTRUMENTS; HYPODERMIC SYRINGE. For the reverse use of hollow needles, see TROCAR.

A′cus. A needle. As, —

Acus Cannulata; a trocar, or tubular needle for discharging liquids.

Acus Interpunctoria; a couching-needle used in operations for cataract.

Acus Ophthalmica; one used in operations for ophthalmia or cataract.

Acus Triquetra; a trocar, or three-sided needle.

Ac′u-ten-ac′u-lum. A needle-holder or forceps; a needle-handle; a *porte-aiguille*.

A-dapt′er. 1. A glass-tube open at both ends, and used to connect a retort with its receiver.

2. A receiver with two opposite necks, one of which admits the neck of the retort while the other is joined to another receiver. It is used in distillations to give more space to elastic vapors or to increase the length of the neck of a retort. See ALUDEL.

3. A tube to adapt or fit an accessory apparatus to the body of the microscope, as the adapter which carries the analyzer of the polarizing apparatus, etc.

Ad′a-tis. A species of fine cotton cloth made in India.

Ad-den′dum. (*Gearing.*) The difference between the *real* and the *geometrical* radius of a circular cog-wheel; that is, between the radius of the *pitch circle* and the outer circle which touches the crests of the teeth.

Ad′dice. The obsolete name of an adze; which see.

Add′ing Ma-chine′. An instrument or machine by which adding of numbers is effected. See ABACUS; ARITHMOMETER.

Ad-dress′ing Ma-chine′. A machine for addressing newspapers and magazines in which the same series of names is repeated from time to time as the day of issue recurs. There are two modes. One is to print the addresses consecutively upon slips which are gummed on the back and fed intermittingly to the cutter which cuts off each address. This is then pressed upon the folded paper or pamphlet, which is placed in position to receive its direction. The other mode is to set up the type of each address in a form, and so arrange the forms that they are successively presented at a spot to which the enveloped papers are consecutively fed.

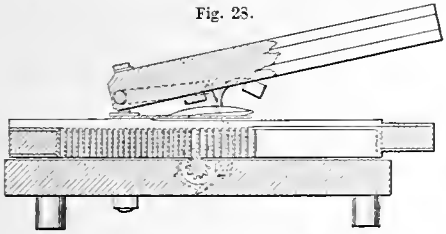
Over twenty patents have been granted in the United States on machines for this purpose.

One of the earlier forms of this device is that described in MOESER's patent, June 24, 1851. The different addresses are set up in columns in a galley, and are brought under the action of a stamp, being moved intermittingly by means of a slide; the addresses are exposed *seriatim* at a slit in a plate, allowing the paper or object to be printed to be pressed down upon the address beneath the slit of the plate, and shielding the paper from the adjoining lines. This series of addresses forms a mechanical record on which changes may be made as they become necessary. This patent was reissued January 30, 1866, and was extended to the year 1872.

CAMPBELL, January 20, 1863. The addresses are set up in parallel columns, and are secured in a common chase. The machine is supported over the chase by end-pieces, and is automatically advanced after each depression of the platen. Resting upon ways which span the chase is a traversing bed-piece with an upright, affording a pivotal attachment for a lever which alternately elevates and depresses a platen on the guide-rod. The elevation of the lever, by means of the toggle, actuates the wheel, which, mashing into a rack, advances the platen to deliver another impression on an advanced point. After exhausting all the addresses in a given column, the bed-piece is moved laterally to bring the platen into correspondence with the next column. A paper is fed beneath the platen just previous to the down stroke of the lever. The form is previously inked so that each address is ready to deliver its impression when called on.

TIFFANY AND SOULE, March 20, 1860. The type addresses are contained in a partitional galley or chase, which is moved by a pawl dependent from the platen lever, as the latter is raised. A pinion on the shaft, whose ratchet is thus actuated by the lever-pawl, is the means of forwarding the galley, a cog at a time, and each line of type as it comes to the wide pinion is separated from the rest by elevation so as to expose it at the slit in the plate above, in contact with the paper which is placed upon it below the descending platen. A sheet metal plate depresses the type after the impression is delivered.

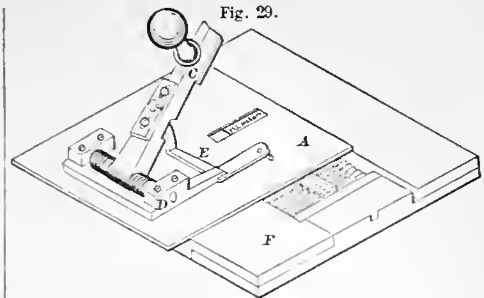
Fig. 28.



Tiffany and Soule's Addressing Machine.

SOULE, October 2, 1860. The forms of the addresses are arranged in columns in the chase *F*, and the plate moves intermittingly above it. The oscillating platen *C* is pivoted to bearings *D*, on the plate *A*, which has a slit brought into correspondence with each address in turn. The plate is advanced intermittingly, after each impression, by the contact of the descending lever with an oblique end to one arm of the bell-crank which is pivoted to the plate, the other end of the lever engaging a rack on the bed-plate.

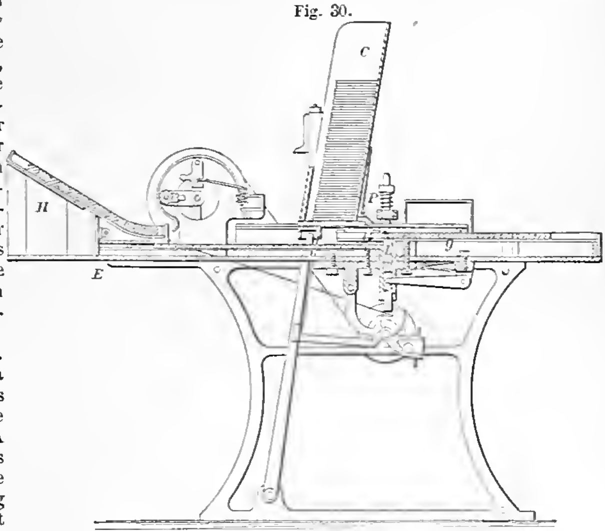
Fig. 29.



Soule's Addressing Machine.

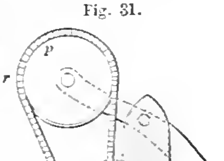
SCHUH, April 26, 1859. The hopper *C* contains the documents, which are discharged consecutively by the movements of a sliding gate which is provided with a heel or step which drives the document before it from beneath the pile. The type addresses are fed down an inclined board *H*, and thence are forwarded along a level channel *E*, to the point beneath the platen *P*. On arriving at this point they are successively raised by the action of a piston *L*, which is raised by a cam on a horizontal shaft beneath. The address is elevated to meet the descending platen *P*, and the paper introduced between them receives the pressure from one and the impression from the other. The type is then forwarded by the type-shifter *G*, along the elevated channel *g*, from whence the addresses are removed in gangs. The notice-bell *R* is actuated by the type at intervals to announce that a certain galley is exhausted.

Fig. 30.



Schuh's Addressing Machine.

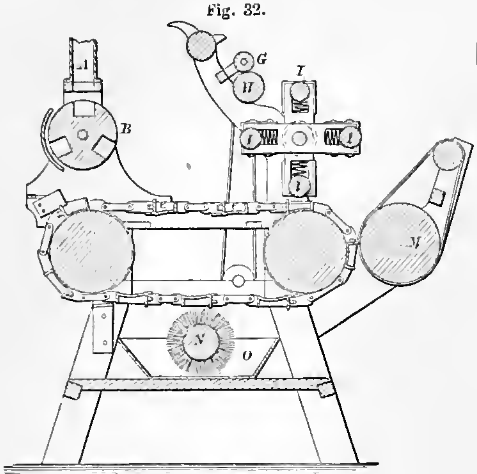
Fig. 31.



Davis's Addressing Machine.

Davis, September 6, 1859. The blocks r on which the addresses are cut or placed are attached in compact column, but independently, to a flexible band which runs over two rollers p t, the lower one, t, being of small diameter so as to cause the outer edges of the blocks to separate at the lowest point of their revolution, as seen in the figure. By this separation the lowest block for the time being is distinctly presented to the paper or envelope which is placed beneath it, and raised to the type by the treadle which raises the table a.

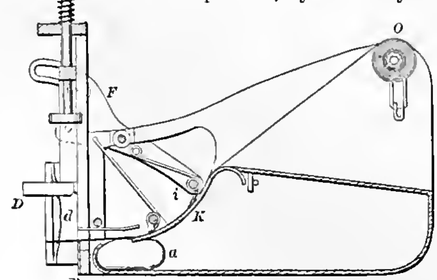
Fig. 32.



Bowlus's Addressing Machine.

Bowlus, May 1, 1860. The endless chain has type-boxes c, which have spring sides for clasping the forms, each of which constitutes an address. The forms are placed in a column in the feed-box A, are taken one at a time by the pockets in the feed-wheel B, and are transferred to the type-boxes in the endless chain. They are carried by the latter beneath the inking-rollers I, which are presented consecutively to the forms, having previously received ink from the ink-supply rollers G H. The paper-feeding and printing-roller M has a travelling apron which feeds the strip of paper to the forms, and the latter are cleansed, as they return in the reversed position, by the rotary brush N, which rotates in the wash-tub O, and in contact with the type.

Fig. 33.



Doty's Addressing Machine.

Doty, January 26, 1864. This machine is for cutting off addresses from a strip of paper previously printed and gummed on the respective sides. The strip is fed from a spool O, and is drawn over the concave bed K by the oscillating arm F, whose finger i engages the paper. The gummed side of the paper being underneath is moistened by the wet sponge a, and passes between the stationary cutter E and the descending cutter D, which is depressed by the spring plunger b, and so actuated by the spring d as to make a shear-cut upon the strip of paper as it removes the address. The feed levers F are pivoted to the frame, and actuated by projections from the descending plunger.

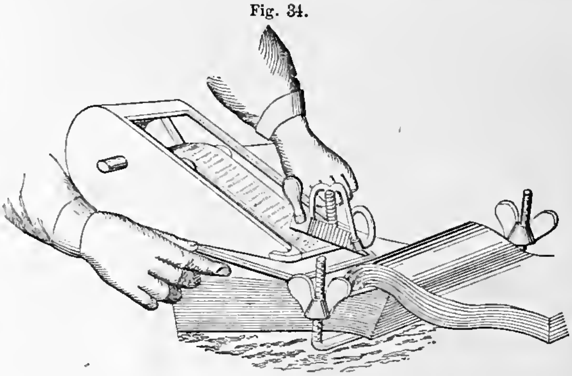
In Dick's machine, October 4, 1859, the addresses are set up in columns in a form, and the printed sheet is cut into strips, each of which has a column of addresses. The reverse side is pasted, and the slip is fed forward one address at a time; the descending stamp-shear removes the address and presses it upon the wrapper or the paper, as the case may be. The pressure of the machine on the pile of wrappers operates the cutter and removes the label.

In Peck and Wright's machine, January 12, 1864, the wooden blocks upon which the addresses are cut are bevelled upon one side, so that a series of them, when placed in a column galley, forms a continuous ratchet, of which each block is a separate tooth by which they are fed forward, preserving the requisite intervals.

In some cases the quads of the forms afford teeth by which the column is advanced.

Barrington, June 14, 1859. The cylinder has

Fig. 34.



Dick's Addressing Machine.

grooved ribs for holding forms of type and presenting them consecutively at the proper point for delivering an impression.

Marshall, November 1, 1859. The "forms" constitute links of an endless chain, which unwinds from one drum and winds on to another, being inked on their passage by one set of devices, and the consecutive links depressed by a stamp on reaching a certain point of their progress at which is presented the paper or envelope to be superscribed.

Nordyke, March 1, 1859. The envelopes on an endless conveyer are fed beneath the forms which are fed upon one track and discharged upon another, being subjected at a given point to the action of a pressure-roller.

Carpenter, May 5, 1857. The forms are placed in pockets in the periphery of a wheel. The newspaper being held above the form, the platen is depressed by a treadle and the impression obtained. On releasing the treadle the spring raises the platen, and the pawl turns the cylinder one tooth, bringing the next name in series beneath the platen.

CAMPBELL, January 17, 1860, patented a machine for printing addresses on the margins of newspapers, simultaneously with the printing of the newspapers, by means of cells or boxes, containing the addresses set up in type and conveyed to the form by means of an endless apron having an automatic, intermittent movement.

BATLEY, January 17, 1860. The type are arranged on slats, so connected together as to be moved successively through the machine. The papers are fed into the machine by finger bars and spurs, and the addresses elevated in succession to make the impression.

LORD, September 7, 1858. The type forming the addresses are inserted in boxes secured spirally on the periphery of a revolving cylinder. The newspapers or envelopes are successively pressed against the type in the boxes by a horizontally reciprocating platen whose action is in concert with the cylinder. The inking apparatus is caused to follow the spiral arrangement of the form, being gradually moved by a screw similar to a lathe-feed screw.

HARRILD's machine (English) consists of a sliding groove of some length, in which is placed a galley containing as many of the required directions as it will hold set up in type and locked up. A treadle moves it along, one notch at a time, under a parchment frisket, till a direction arrives just under the aperture cut in the frisket, the newspaper envelope is laid over it, and the treadle brings a platen down upon the newspaper.

The galley then passes along, notch by notch, till its directions are exhausted, when it is superseded by another.

Ad-he'sion Car. A car whose wheels are adapted to grasp a rail or to bear upon it in such a way as to have an adhesive or tractive power greater than that due merely to the weight of imposition.

Among the forms may be mentioned: —

The *cogged rail.* See RAILROAD.

The *center rail,* with a horizontal pair of gripping-wheels. See RAILROAD; CENTER RAIL.

Another form is a wheel with an angularly grooved periphery, which bites the flanges of a double-headed rail.

In the early history of railroad engineering many devices, especially the cogged rail, were employed to give adhesion, or tractive grip upon the rail. These were eventually laid aside as more correct views were attained. In climbing inclined planes, however, devices of this kind are yet found useful, and are noticed under the appropriate heads, cited above.

Coefficients of Adhesion of Locomotives per Ton upon the Driving-Wheels.

	Lbs.
When the rails are very dry, . . .	670
When the rails are very wet, .	600
In misty weather, ...	350
In frost or snow, ...	200

In coupled engines the adhesion is due to the load upon all the wheels coupled to the drivers.

The adhesion must exceed the traction of an engine upon the rails, otherwise the wheels will slip.

Ad'it. A *drift,* or nearly horizontal tunnel forming a road or drain in a mine, by which the ore is extracted or water carried off. Its discharging end is at the natural surface. A *day-level,* or *sough.*

The great adit in Cornwall drains the waters from the Gwennap and Redruth mines, and is nearly thirty miles long. It discharges its waters into the sea, forty feet above high-water mark.

Adits may be driven either along the course of a vein or bed or through an unproductive stratum of rock, and are frequently run in a direction transverse to the general bearings of the veins or lodes, with a view to exploration; such an adit is termed a *cross cut.*

In the early working of a mine, the adit, from motives of economy, is made as short as practicable; but as the operations progress it is often advisable to drive another at a lower level and of greater length, to avoid the difficulty of pumping or lifting the water from a considerable depth.

Ad-just'ing Screw. A set-screw of an instrument by which one part is moved upon another, either for focus, level, tension, or otherwise.

Ad-just'ing Tool. (*Horology.*) A tool by which the snail of the fusee is regulated so that its increase of diameter may exactly countervail the decreased strength of the spring as it unwinds in the barrel. The object is to obtain an exactly equal power at all times upon the train.

Ad'mi-ral. A leading ship of a squadron. (From Sar. *Emir,* the Sea.)

> "To be the mast
> Of some great ammiral." — *Paradise Lost,* B. I.

A-do'be. Adobes, or unburnt bricks, are principally in vogue in the plains of Shinar and Egypt, and in China and certain portions of North America inhabited by the Puebla Indians. If well *burned,* he clay forever loses its plasticity, and cannot again › reduced to a mortar. If it be merely *dried,* it will assume its original condition, as it came from the pug-mill. Such has lately (1871) been the experience of the Chinese in the vicinity of the Hoang-ho, whose houses of adobes are reduced to mud-heaps by the overflow of the river. Mr. Tomlinson, C. E., of London, has treated this matter more fully than any other author writing in our language, and he says: "The first action of heat is to drive off hygrometric water; the clay then becomes dry, but is not chemically changed, it does not cease to be plastic. On continuing to raise the heat, the chemically combined water is separated, and the clay undergoes a molecular change which prevents it from taking up water again except mechanically. With the loss of this chemically combined water clay ceases to be plastic."

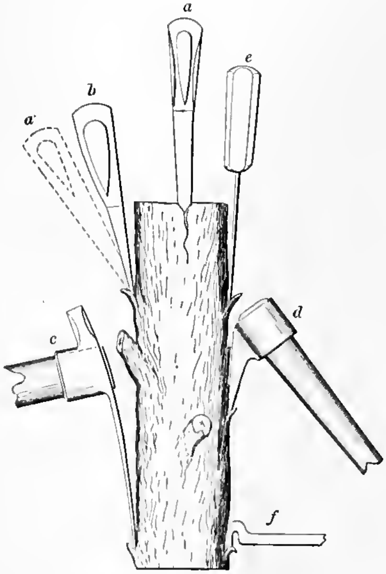
In the directions which have been published for building with adobes, it is recommended that they should be guarded, by some material impervious to water, from absorbing moisture from the ground, and also that the roof should be made to project not less than two feet in order to shed the water and prevent its running down the walls. These directions seem to indicate the weak point, and the experiences derived from the dry plains of Asia and Africa, and the elevated arid regions of Northern Mexico and Lower California, do not apply so well to our more humid climate.

The mold for making adobes resembles the ordinary brick-mold in having four sides and having handles at the ends, but no top or bottom. It is much larger, however, and sometimes a pair are placed in a single frame. It is placed in position on the drying-ground, filled with clay, and when the top is smoothed by a striker, the mold is carefully raised, leaving the adobe to dry for a few days, when it is turned to expose the other side. A few weeks of favorable weather complete the drying. It is a cheap material and easily built up. It does not appear likely ever to become a favorite mode of building in those parts of the United States which are at present most thickly populated. It will not do to make too general a statement in a country whose climate varies between Alaska and Mexico.

Ad-vice′-boat. A fast-sailing vessel used for reconnoitering. First used, say the authorities, in spying the operations of the French fleet in Brest, previous to the battle of La Hogue, 1692. Of course Themistocles and the consul Caius Duilius never had any light amphiproræ to "overhaul" the Persians or the Carthaginians, "and when found make note on."

Adze. The adze is a very ancient tool, and has a curved blade whose edge is at right angles to the handle; differing from the axe, in which the blade is parallel to the handle. The forms and sizes differ

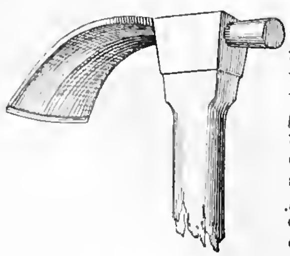
Fig. 35.



with the character of the work, and in some cases the bit is gouge-shaped in addition to its curve in the plane of its motion. It is swung in a path of about the same curvature as the blade, the shoulder-joint being the center of motion, and the entire arm and tool forming, as it were, an inflexible radius.

The above cut from Holtzapffel gives an idea of the presentation to their work of various wood-cutting tools. *a a* represent the axe or hatchet, with two bevels; *b*, the broad-axe, or single-bevelled axe; *c*, the adze; *d*, the Indian angular-bitted adze; *e*, the chisel; *f*, the mode of presentation of a metal-cutting tool, introduced for the sake of comparison.

Fig. 36.

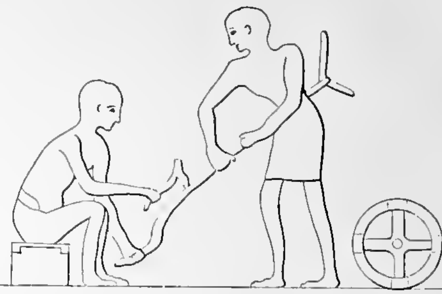


Adze.

Fig. 36 is the modern adze.

The adzes of ancient Egypt were of different forms;

Fig. 37.



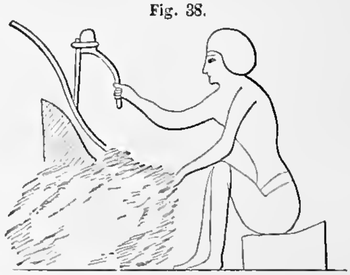
Egyptian Adze. (Thebes.)

the edges curved or straight, the blade generally straight.

The figures in the accompanying cut are from a building in Thebes; one is holding a carriage-pole or tongue, while the other is dressing it to shape with an adze.

In the other illustration the blade of the adze is shown confined by a band or strap to the helve. The

Fig. 38.



Egyptian Adze. (Thebes.)

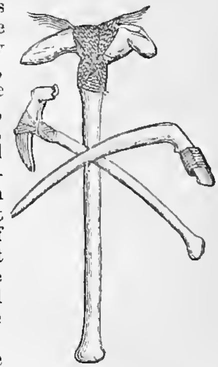
adze appears often in the Egyptian painting and sculpture, and was the principal tool in ancient Egypt for fashioning articles of wood. Its blade was of bronze and the handle of tamarisk.

The Roman adze (*ascia*) is shown on many ancient monuments. Some have a rounded edge, some a straight. It was then, as now, a ship-builder's tool.

The *acisculus* had a similar rounded head, but was a stone-mason's tool, having a square face and pointed peen.

Among many of the West India Islanders adzes and axes of shell were used. When it was procurable they were made of flint; this was worked into the shape of a tool and attached by sinews or cords to a helve, or fastened to a withe (see Axe), or, as in Figs. 39, 40, the cutting material of shell, flint, or obsidian was lashed to a stock. Metal superseded the other materials in most parts of the world, but many barbarous nations of America and Polynesia yet make their weapons of the material generally discarded at a very distant date in the Old World.

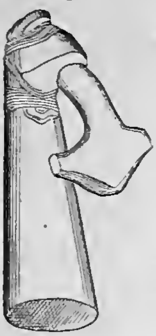
Fig. 39.



South-Pacific Adzes.

Fig. 39 represents three stone adzes of the South

Fig. 40.



Chalam Adze.

Pacific, and Fig. 40 a stone adze of the Chalam Indians, who occupy the shores of Puget Sound. It suggests the most ancient form of the tool, employed especially for digging out the canoes from the solid log. These canoes were common at a period before the discovery of iron in Europe, and their remains are there found associated with the implements of the stone and bronze ages.

The stone adze of the Tahitians, when visited by Captain Cook, was similar to those represented in Fig. 39. Large ones for cutting down trees weighed from six to seven pounds; smaller ones, for carving, but a few ounces. All of them needed continual sharpening, for which purpose a stone was kept in readiness.

Adzes are known as

Flat, when the blade has a straight edge;

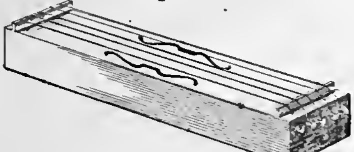
Rounding, when the edge is curved;

Notching, with a straight blade and straight edge.

Æ-o′li-an. A contrivance attached to pianos by which a wind instrument may be introduced as an accessory at the pleasure of the performer, air being supplied by a bellows worked by a pedal.

Æ-o′li-an Harp. A species of musical instrument, the sounds of which are produced by currents of air passing over its strings, which are commonly fifteen in number. Its principle may be familiarly

Fig. 41.



Æolian Harp.

shown on a large scale by the action of the telegraph wires stretched from one pole to another. On a windy day especially these will be found, by any one stationed near, to emit musical tones rising and falling in proportion to the strength of the wind, and more or less grave in proportion to the tension of the wires.

Were the number of wires increased, and their length and tension properly varied, these would constitute a perfect Æolian.

A common mode of construction is to make a box of thin wood and of suitable length, to set beneath a window-sash. It may be five or six inches in width and depth. At one end of the box are pins equal in number to the strings employed, and at the other as many pegs; the strings, being made fast to the pins at one end, are tuned by turning the pegs at the other. The box is open on the sides presented towards the room and to the exterior air, and the strings are sounded by the passage of the air through the box. Catgut is usually employed for the strings.

It is supposed to have been invented by John J. Schnell, musical-instrument maker to the Countess d'Artois. It was suggested by the vibration of the strings of a harp placed in a breezy situation. Exposed for sale in 1789 under the name of *Anemo Chorde*.

Its use was revived by Kircher.

One of the Talmuds says that the harp of David sounded when the north-wind blew on it, and it has been suggested that he had an Æolian, as we understand it. The sounding of his harp by a gust of wind would be nothing extraordinary if it stood near his north window, which was probably open for air and chosen for its coolness and shade in the climate of Judæa. David wrote a good deal in praise of shade and cool drink.

Æ-o-li′na. (*Music.*) A modification of the accordeon, by Wheatstone, leading to the concertina.

Æ-ol′i-pile. Was invented or first described by Hero, of Alexandria. It was a rotary engine, in which steam issued from the ends of bent arms and by reaction rotated the hollow shaft or sphere to which the arms were attached. Hero's engine revolved in the Serapion about 150 B. C., and many applications for patents in the United States and other countries have been made for the same device within a few years past. Inventors seem loth to give up this simplest form of engine, but it is not probable that it will ever prove a useful or economical one.

Fig. 42.

Hero's Steam-Engine.

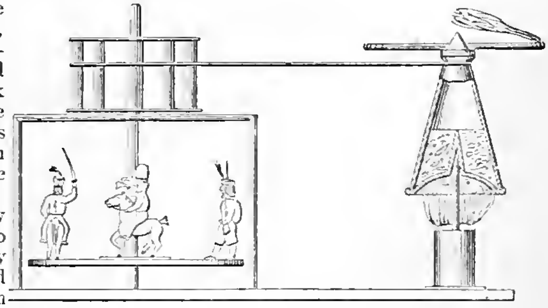
The above cut is copied from Hero's "Spiritalia," edited by Woodcroft, of London. See STEAM-ENGINE.

ELY'S Æolipile, 1867, is adapted for rotating a toy. It is poised with its boiler on a central vertical pivot, and is connected by a band with the shaft on whose platform the toys are displayed.

A more serious attempt at applying the principle of the Æolipile is BANTA'S Rotary Steam-Engine, May 28, 1867. The hollow arms rotate in closed cylinders, and their shafts are so connected as to be continuous, the packing of the series being performed at one operation. The steam passes in at the axis of each, and issues at a tangent, driving the wheel by reaction.

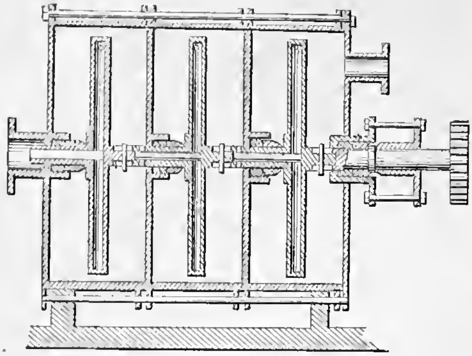
It is attempted to obtain the use of the steam in a number of successive chambers, in apparent forgetfulness of the loss by back-pressure. The steam enters at the left, and, issuing from one pair of arms, escapes into the first chamber; from thence it passes to the second *wheel*, so called, and emerges into the second chamber, and so on. The hubs of the *wheels* are clutched together, so that their cumu-

Fig. 43.



Ely's Æolipile.

Fig. 44



Rotary Steam-Engine.

lative effect is eventually utilized upon the main shaft, on which is the pinion. See REACTION STEAM-ENGINE.

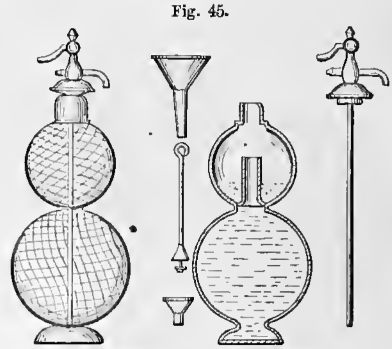
Æ-ol'o-phon. The seraphine ; the predecessor of the melodeon and parlor organ.

Æ'o-lus. A small ventilating machine for renewing the air of apartments.

A'er-a'tor. 1. An apparatus for making aërated waters. These consist simply of pure water impregnated either naturally or artificially with gases, and are used largely, when combined with vegetable acids and sugar, as refreshing refrigerating beverages in warm weather, and in medical practice during feverish conditions. The insipid taste of melted snow or rain-water is chiefly due to the small quantities of gases therein contained ; but when such water has come in contact with the atmosphere by trickling down a ledge of rocks, and rushing along a boiling, rapid stream, or being dashed to and fro by the winds, it absorbs the gases from the air and is naturally aërated. Ebullition dissipates the gases contained in spring-water, rendering it as flat and insipid to the taste as before it was aërated. The waters of many mineral-springs are aërated in a natural way by the gases arising from the decomposition of minerals washed together from their subterranean beds. The first attempt to prepare artificial aërated waters was made by M. Venel by dissolving in a pint of water two drachms of fossil alkali to which he added an equal quantity of muriatic acid. He used a vessel with a narrow neck to prevent the escape of gas, depositing the ingredients in such a manner that they would not communicate with each other until after the vessel was corked. In this case the gas evolved in a vial nearly full and closely corked suffers such a degree of compression as to greatly promote its combination with the water. M. Venel supposed that the real ingredient to which it owed these qualities was common air. Two memoirs of his experiments were read before the Royal Academy of Sciences in 1750. Dr. Priestley greatly improved upon the discoveries made by Venel and others, and in 1767 contrived an easy method of impregnating water with the principle then denominated "fixed air," by placing shallow pans of water near the surface of the fermenting vessels of a brewery, which in a few hours became pleasantly impregnated with the escaping gas. He found upon experiment that the impregnation was accelerated by pouring the water from one vessel into another ; but it did not occur to him till the year 1772 that this could be effected by the gases dislodged from decomposing chalk and other calcareous substances confined in an air-tight vessel. Dr. John North's apparatus for impregnating water with carbonic acid was invented in 1775. Between the years 1807 and 1852 thirty-one English patents were granted for apparatus and methods for preparing aërated water, and fifteen patents for vessels to hold such waters, and for methods for bottling. The most common beverage is *Carbonic Acid Water*, generally spoken of as soda-water, though it seldom contains any soda. It is prepared in large quantities by placing whiting, chalk, or marble-dust in an air-tight, lead-lined vessel with water and sulphuric acid. The sulphuric acid combines with the lime to form sulphate of lime (plaster of Paris), and carbonic acid is evolved as gas. The latter is received in a reservoir, and is afterwards forced into water agitated by machinery so that the latter absorbs about five times its own volume of the gas. The water then constitutes a brisk sparkling liquid, with a pungent but pleasant acidulous taste. It may be prepared on a small scale, for family and medical purposes, by using the apparatus known as the Gazogene or Seitzogene.

The complete apparatus is shown in Fig. 45, and also the separated parts. The lower globe is filled with water by means of the long funnel, and then the tube is closed by the stopper, and the powders, consisting of bicarbonate of soda and tartaric acid, are then placed in the upper globe by means of the small funnel. The stopper is then withdrawn, and the long tube is inserted and screwed closely

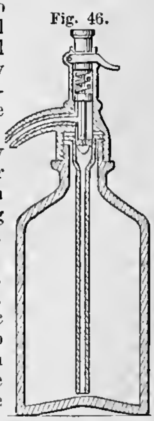
Fig. 45.



Portable Soda-Water Apparatus.

down. The apparatus is then inclined so that the upper globe is about one third filled with water, then placed erect and allowed to stand two hours. If the screw stopcock at the top be opened, the carbonated water will flow out readily into any vessel placed to receive it. Occasionally bisulphate of potash is used instead of tartaric acid, to save the expense of the latter.

Fig. 46.

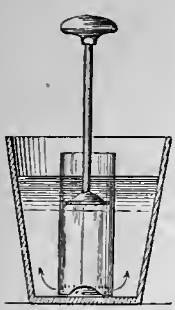


Warker's Bottle for Aërated Liquids.

The devices which are ordinarily called *Soda-Water Apparatus*, or *Soda-Fountains*, are those used in drawing the beverage and mingling it with the flavoring syrups, etc. See SODA-FOUNTAIN.

In the bottle for aërated liquids, patented by WARKER, March 18, 1862, the spout of the metallic fountain-head is lined with glass to keep the liquid from contact with the metal. The shoulder on the top edge of the neck, the alternate grooves, and the ridges on the neck are used to strengthen the attach-

Fig. 47.



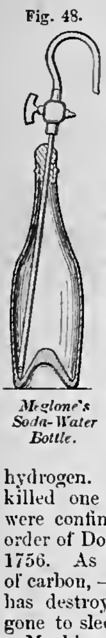
Pratt's Aërator.

ment of the metallic cap to which the fountain-head is screwed.

In Pratt's apparatus for aërating liquids, September 10, 1867, the plunger has a concavity which carries down the air; the latter is expelled as the plunger reaches the convex bottom, and is driven through the holes in the tube and disseminated through the liquid in the outer vessel.

Meglone, August 14, 1866. The tube is introduced through the cork; the liquid enters holes at its lower end, and is discharged at the goose-neck, when the stop-cock is opened. The bottle may be charged by means of an auxiliary tube, also passing through the cork, and either removed or closed when the bottle is filled with the aërated liquid.

Fig. 48.



Meglone's Soda-Water Bottle.

The liquid contents of these bottles may be aërated by means of a simple air-pump placed in temporary connection with the tube when the eduction nozzle is removed; or chemicals may be introduced whose reaction liberates gas when they meet in solution. The aëration of sparkling champagne and Catawba is produced by adding a small amount of white sugar to the wine in bottling, the slight fermentation eliminating alcohol therefrom and liberating carbonic acid gas. The effervescing drinks, such as ginger-beer, are also dependent for their ebullition upon the fermentation of the ingredients and the development of the same gas. Carbonic acid, in moderate quantities, has a very salutary effect upon the stomach, while it is so fatal when breathed into the lungs. As the "after damp" or "choke damp" of the miner, it has often killed those who survived the explosion of the carbureted hydrogen. At the Black Hole, near Calcutta, it killed one hundred and twenty-four persons who were confined in a room eighteen feet square by order of Dowlah, Viceroy of Bengal, June 20, 1756. As a gaseous result of the combustion of carbon, — as of charcoal, for instance, — it has destroyed the lives of many who have gone to sleep in ill-ventilated rooms.

Machines are made on a large scale for charging soda-fountains.

Cameron's aërator has a gas-generator *a* made of cast-iron, lined with sheet-lead to prevent the action of the sulphuric acid upon the iron. The vessel contains fifteen gallons, and is partially filled with water and whiting or other carbonate of lime. The agitator *b* is also covered with sheet-lead, and its stem passes through a stuffing-box *c*, at the top of the vessel. The acid-holder *e* is formed of lead, and has a capacity of two gallons, and is partially filled with oil of vitriol. The acid is kept from running down into the generator by means of the conical plug *f*, which fits into a conical seat in the leaden pipe *g*. This plug is attached to a rod, and moves up and down through the stuffing-box *h*, and is prevented from turning round by means of a pin *k*, moving in a slit in the bridle *l*; the screw-nut is riveted loosely into the top of the bridle. The pipe *n*, which forms a communication between the top of the acid-holder *e* and the pipe *s* in which the plug-rod moves, preserves an equilibrium of pressure, so as to prevent the acid from rising higher in the pipe *s* than the level of the acid in the acid-holder; by which means the brass-work of the stuffing-box is preserved from injury. To prevent any of the sulphuric acid from being carried over by the effervescence, an intermediate vessel *o*, containing about three gallons, is formed of lead or lined with that metal. The intermediate vessel is filled with water above the eduction-pipe from the generator *a*.

The impregnator *v* holds about sixteen gallons, and is made of cast-iron lined with lead, or of tin-lined copper, and the agitator *m* is covered with lead or is made of wood. The impregnator is filled to the dotted line with water, to which, in making saline waters, the proper proportion of sesquicarbonate of soda, carbonate of magnesia, or other ingredients is added.

For the ordinary soda-water no medicament is added. A pressure-gauge *t* is connected by a leaden pipe.

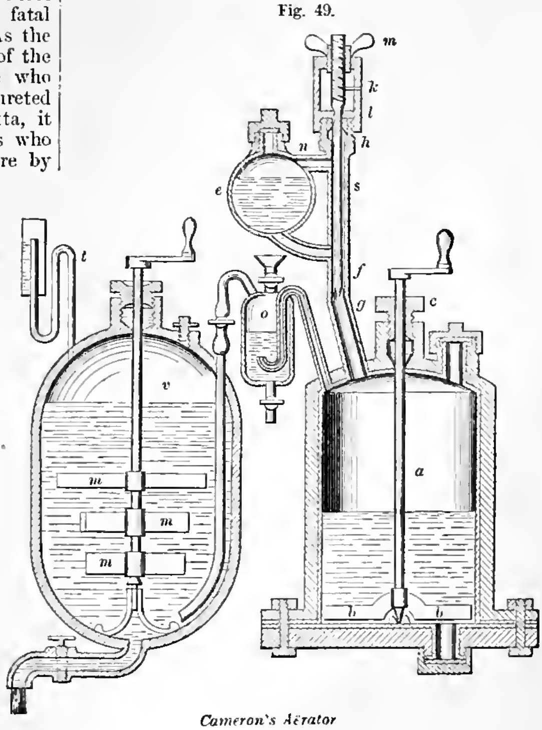
The operation is as follows: —

By turning the nut *m* the plug is raised, and acid is allowed to run into the generator *a*, when it acts upon the carbonate, disengaging the carbonic acid gas in quantity proportioned to the amount of acid admitted. The plug is again lowered when the ascertained proper amount has entered the generator. The gas passes by the intermediate vessel into the impregnator *v*, where it is absorbed by the water.

The aërated water is drawn off from the impregnator into glass bottles, and tightly corked; or is removed and placed in connection with the ordinary soda-fountain apparatus by which the liquid is drawn into glasses.

Bakewell's soda-water apparatus (English) has the generator and impregnator in the same vessel, separated by a diaphragm, and connected by a pipe.

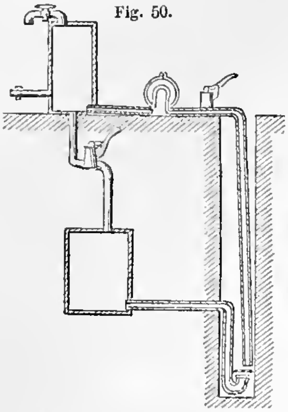
Fig. 49.



Cameron's Aërator

The vessel is on trunnions, and is oscillated so as to allow a pendulous stirrer in the lower vessel to agitate the solution of the carbonate of lime. The gas passes to the upper chamber, where it performs a circuitous course in the water which absorbs it.

Fig. 50.



Apparatus for bottling at the Spring.

Other apparatus depends upon mechanical means for injecting the gas into the water by means of a pump or syringe.

Many other devices might be cited, but they contain substantially the same parts under modified arrangements, — a generator with a means for admitting the acid, a conductor for the gas, and an impregnator in which the water is permeated by the gas evolved.

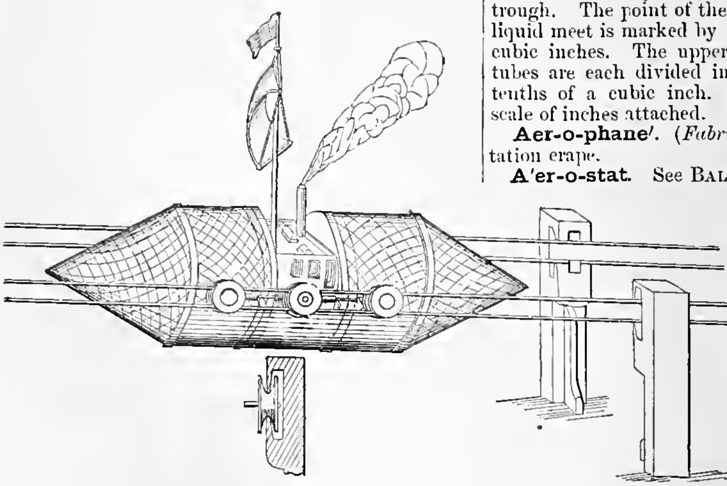
THOMAS's apparatus for bottling mineral waters, June 18, 1867, is applied directly at the spring.

The water is drawn from a considerable depth through a pipe let down in the spring; a perforated plate of glass is placed in the water below the mouth of the tube, and jets of gas from a reservoir are discharged below the plate.

The object is to charge mineral-water with gas, or to add an extra supply of gas thereto.

2. A contrivance for fumigating grain in bulk, to destroy fungi and insects.

Fig. 51.



Fontaine's Aërial Railway.

A-e'ri-al Car. A car adapted for traveling in the air.

The name is somewhat loosely applied, and may mean one of three things: —

1. The basket or receptacle of a balloon.

2. A car whose weight is partially or entirely counterbalanced by a balloon, and which travels on wires by means of driven wheels. See next article.

3. A car on an elevated railway.

A-e'ri-al Rail'way. An attempt to govern the balloon or aërostat by guiding rails or wires stretched between posts.

FONTAINE's Aërial Railway, February 5, 1867, may be taken as a sample.

The weight of the car is counterbalanced by an attached balloon. The cigar-shaped car is driven by steam, the deeply indented side-wheels travelling upon wires which rest upon brackets whose flanges project into the circumferential depressions in the wheels.

The wire-way supported on posts has been adopted for carrying freight. See WIRE-WAY.

A'e-ro-hy'dro-dy-nam'ic Wheel. A mode of transmitting power to great distances proposed by a Belgian engineer, Mr. Calles. The plan of Mr. Calles is to make use of air under a certain degree of compression as the vehicle of the force to be transmitted, not by accumulating the air thus employed in reservoirs, but by driving it, by the operation of the original motor, directly into a tube extending to the point of final application, where it is to be discharged beneath a wheel submerged in water, which it is to turn by its ascensional force. See AIR AS A MEANS OF TRANSMITTING POWER.

A'er-om'e-ter. An instrument invented by Dr. M. Hall, for ascertaining the mean bulk of air or gases in pneumatic experiments.

It consists of a bulb of glass of four and one half cubic inches' capacity, blown at the end of a long tube whose capacity is one cubic inch. This tube is inserted into another tube of nearly equal length, which is supported on a sole, and the first tube is sustained at any required height within the second by the pressure of a spring. Five cubic inches of atmospheric air, at a medium density and temperature, are introduced into the bulb and tube, of the latter of which it will occupy one half. The other half of this tube and part of the tube in which it is inserted are occupied by the liquid of the pneumatic trough. The point of the tube at which the air and liquid meet is marked by the figure 5 to denote five cubic inches. The upper and lower halves of the tubes are each divided into five parts, representing tenths of a cubic inch. The external tube has a scale of inches attached.

Aer-o-phane'. (*Fabric.*) A light gauze or imitation crape.

A'er-o-stat. See BALLOON.

A'e-ro-steam En'gine. An engine in which the expansive power of combined heated air and steam is used in driving a piston.

The *Air Engine* followed closely in the wake of the Watt Steam-Engine.

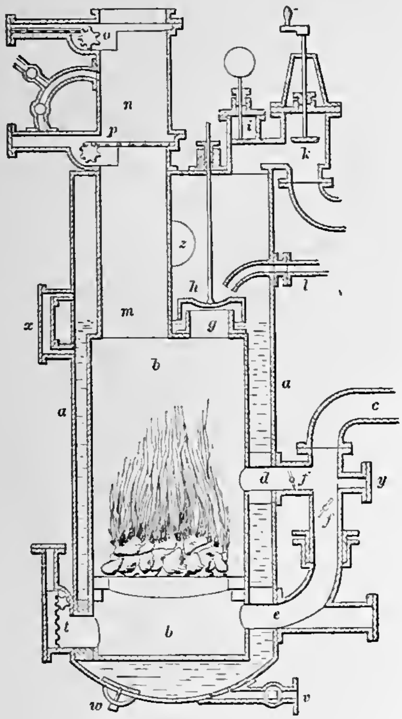
Oliver Evans, during the latter portion of the last century, suggested the combination of the heated gases and air with the steam, as a motor. He called it a VOLCANIC ENGINE, which see.

Glazebrook used moistened hot-air in his Air Engine, English Patent, 1797. See AIR ENGINE.

The air is moistened before reaching the cylinder in PAINE's Engine, United States Patent, November 30, 1858. In this case it is the cool refrigerated air that is moistened, and the amount of moisture would be very far below saturation when the air came to be heated.

The same may be said of Glazebrook's, 1797, with the additional remark that Glazebrook condensed the air in the preliminary process, before exposing it to moisture, so that the heat incident to its condensation would enable it to absorb more water, but still far less than would be sufficient to saturate it when it came to be heated by the furnace.

Fig. 52.



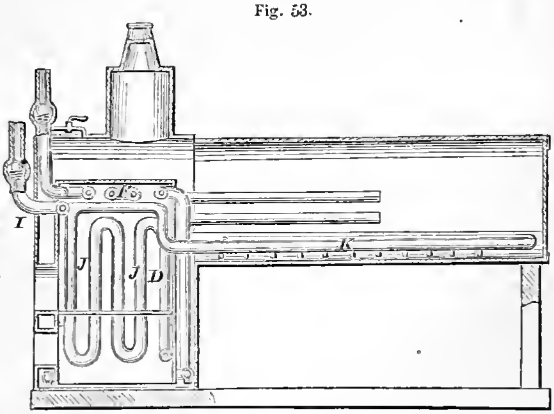
Bennett's Aëro-steam Engine.

BENNETT, United States Patent, August 3, 1838, introduced, or at least adopted, two new features: 1. He conducts the incoming charge of air to the furnace, and makes it the means of maintaining combustion under pressure; 2. The furnace is air-tight, and the volatile results pass through the steam-boiler, are washed, and pass, fully saturated, to the cylinder. See AIR ENGINE.

The steam and air might have been combined in any required relative ratio in this boiler, but the inventor does not appear to have supposed any specific proportion was necessary. *a a* is a vertical cylinder constituting the shell of the boiler, *b b* a smaller cylinder placed within the former and forming the furnace and ash-pit; this is entirely surrounded by water. *c* is a tube connected with a blowing-machine, and having two branches *d* and *e*, — the former of which admits a portion of air above the fuel, and the latter a portion into the ash-pit below the fire-bars. Two throttle-valves, or dampers, *f f*, are provided to regulate the draft through each branch. *g* is a short cylindrical neck, through which the smoke and heated air pass into the steam-chamber, where they mix with the steam, and with it pass to the working cylinders. The neck *g* is covered with a valve *h* opening upward, the sides of which are turned down to cause the heated air to pass through the water, and thereby give out a portion of its heat to the latter; this also serves to wash the heated air and arrest grit which would injure the cylinder and piston. *i*, a safety-valve, *k*, a valve by which the pipe that conveys the steam to the engine can be closed when required; *l*, the pipe by which the water is conveyed to the boiler from the feed-pump; the end of this pipe enters the boiler and delivers the water on to the top of the valve *h*; this is with a view to prevent the valve becoming excessively heated by the action of the fire. *m* is the fuel-spout by which coal is introduced into the fireplace; on it is bolted the hopper *n*, having at its upper end a flat sliding valve *o*, and another one *p* at its lower end; these valves slide in grooves, and are moved by means of racks and pinions. They are ground to their seats so as to make air-tight joints, and during the whole time the engine is in operation the coal-hopper is kept closed by one or other of these valves. In kindling the fire the valves *o* and *p* are both opened, lighted kindling is dropped through the chute, and then a quantity of fuel. The valves are then closed, the blower started. When the engine is set to work, it forces air into the furnace both above and below the fuel at each stroke, which, having no vent to escape but at the valve *h*, accumulates in the furnace until its pressure somewhat exceeds that of the steam upon the valve *h*, when it lifts the valve, and, rising up through the water, mixes with the steam, and passes along with it to the engines. *t* is a slider, by opening which the ashes from the furnace can be withdrawn; when this is requisite the dampers *f f* must be first closed. *v* is the blow-off cock, by which the water can be discharged from the boiler when required, and *w* is a hole covered by a door for removing any mud which may have accumulated. At *x* is a glass gage to show the height of the water in the boiler, and at *y* is a glass eyepiece through which the state of the fire can be ascertained. *z* is the man-hole of the boiler.

WILLIAM MONT. STORM'S experiments in combined air and steam covered the period 1851 – 55, and perhaps later. His Cloud Engine, in which steam and air, in a condition resembling fog, were used to propel a piston, was exhibited at the fair of the American Institute, New York, in 1855. The machine appears to have failed to realize the expecta-

Fig. 53.



Tanger's Steam-Generator.

tions of the inventor. There was a lack of adjustment somewhere, it may be supposed, but the end is not yet.

In Washburn's Air-Heater and Steam-Generator, United States Patent, September 5, 1865, the air is also introduced under pressure into the furnace, and then passed through a cleansing-tank before being added to the steam evolved in the coil of pipe which constitutes the steam-generator. In this apparatus full saturation is obtained. See illustration in Air Engine.

Stillman's Hot Air and Steam Generator, August 9, 1864, has also the combination of air and steam.

Bickford's Patent, June 6, 1865, may also be examined in this connection.

In Tanger's Steam Generator, December 4, 1866, the air is injected into the pipes *E* and *I* by means of a force-pump, and after being heated while passing through the convolutions of the pipes *F* and *J*, is forced into the boiler by nipples, as shown at *K*.

In Tarr's Aëro-Steam Engine, 1867, the air is heated within the furnace, and is thence forced through the pipe into the steam-chest, where it mingles with the steam coming through the pipe; and the mixture of steam and hot air is by means of a slide-valve admitted alternately above and below the piston in the ordinary way, so as to produce the usual reciprocating motion.

Warsop's Engine (English), 1869, is started by steam in the ordinary manner. A single-acting air-pump, worked from the crank shaft, compresses air to a little more than the boiler pressure; the air then passes through a long circuit of straight and coiled pipe, which traverses the exhaust-pipe, makes several spiral coils in the chimney, then descends at one side of the fire-box, is exposed to the full fire, and finally passes by a valved opening into the boiler at the bottom of the water-space.

Warsop's object is similar to that of several of his predecessors, to make steam assist the expansive force of air, and to avoid the difficulties of lubrication incident to the use of hot air alone. He attempts to obtain the maximum effect from mixed air and steam by instituting a certain approved proportion between the two. It is quite probable that such a ratio may be found, and that it may secure substantial economical advantages.

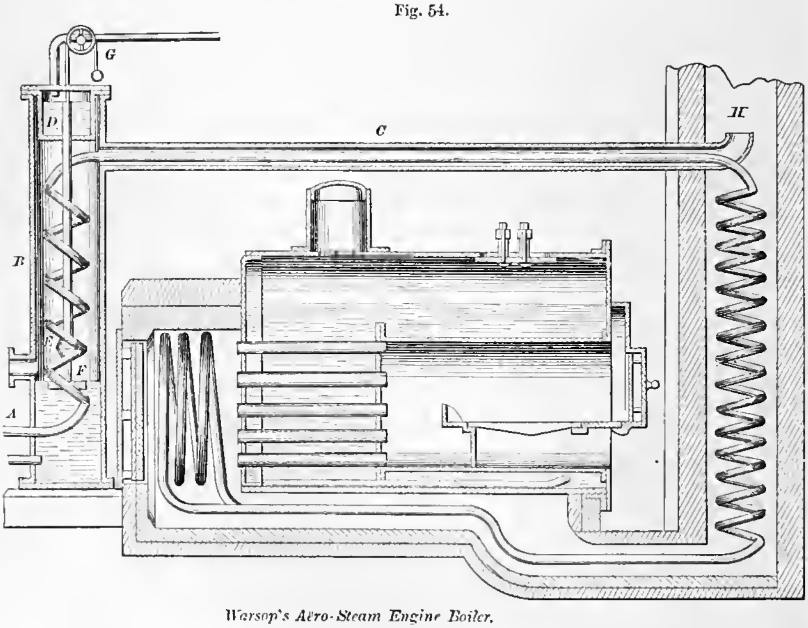
The pipe *A*, through which the air is forced into the boiler by the action of the air-pump, is of iron, and is $1\frac{1}{16}$ inches in diameter outside, and $1\frac{1}{4}$ inch bore. On leaving the pump the pipe is first led to the heater *B*, shown on the left of the engraving, wherein it is exposed to the exhaust steam. The heater consists, as will be seen, of a cast-iron cylindrical vessel placed in a vertical position and provided with two branches — one near the bottom and the other near the top — through which the exhaust steam respectively enters and escapes from the casing. At the top of the heater is placed a small cylindrical tank *D*, exposed at the bottom and sides to the exhaust steam, and perforated around the upper part of the sides, so that in the event of its receiving an excess of water the latter may overflow and fall to the bottom of the heater. Through a stuffing-box at the bottom of the tank there passes a tube with a rose *E* at the lower end, this tube being carried by a float *F*, which swims in the water at the bottom of the heater, as shown, and, by means of a cord passing from the top of the tube, works a cock *G*, which regulates the supply of water to the tank at the top of the heater.

The air-pipe *A*, after leaving the heater just described, passes along the exhaust-pipe *C* to the chimney *H*, and, descending the latter spirally, as shown, passes into the flue beneath the boiler. Here it is led backward and forward, as shown in the plan, and after making several convolutions in the smoke-box, is led back to the front of the boiler, where it communicates with a valve-box, containing an ordinary, light clack-valve. The object of this valve is to prevent water from entering the air-pipe when the engine is stopped. From the valve-box a pipe is led down within the boiler to the bottom of the latter, this pipe being perforated at intervals on the upper side. The perforations are placed closer together at the farther end of the pipe than they are at the end at which the air enters, and by this means an equable distribution of the air at the different parts of the boiler is insured.

The lengths of the various portions of the air-pipe are as follows: In feed-water heater, 12 feet; in exhaust-pipe, 13 feet 6 inches; in chimney and flues, including coils in smoke-box and under boiler, 58 feet; total, 83 feet 6 inches. The total external surface exposed by this pipe is thus about $36\frac{3}{4}$ square feet.

The principal dimensions of the

Fig. 54.

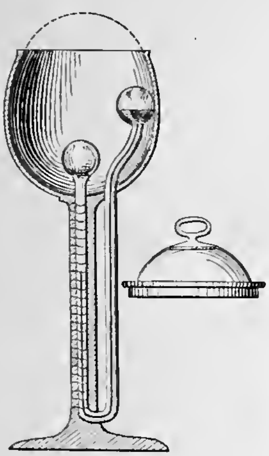


Warsop's Aëro-Steam Engine Boiler.

boiler are as follows: Length, 8 feet; diameter of shell, 3 feet 6 inches; diameter of fire-box flue, 2 feet 2 inches; length of fire-box and combustion-chamber, 5 feet; and length of tubes, 3 feet. The tubes are 41 in number, most of them being $2\frac{5}{8}$ inches, and some of them $2\frac{5}{16}$ inches diameter. The total effective heating surface exposed by the boiler is about 130 square feet.

Æ'thi-ops Min'er-al. A compound of sulphur and mercury, so called on account of its blackness. The black sulphuret of mercury, formed by triturating together mercury and sulphur until the two combine and form a black powder.

Fig. 56.



Æthrioscope.

Æ'thri-o-scope. An instrument for measuring the degrees of cold arising from exposure under different conditions of the sky. A highly polished metallic cup or concave mirror is placed upon a pedestal of convenient hight, and a differential thermometer is placed within it so that one of the bulbs of the thermometer shall be exactly in one focus of the mirror; the other bulb being not in either focus is not affected by the pulsations, the effects of which on the cup are concentrated upon the first bulb, the air in which being suddenly contracted upon its exposure to a clear sky, the liquid in that branch of the stem is caused to rise. The cup is kept covered with a metallic plate, except at the moments of observation.

Af'fi-nage. The act of refining or making purer, as the affinage of metals.

Aft'er-rake. The part of the stern which overhangs the keel.

Aft'er-sail. (*Nautical.*) A sail whose center of effort is abaft the general center of effort of all the sails. Head-sails are relatively before the said point, and by means of these head and after sails a ship may be maneuvred.

Aft'er-tim'bers. (*Shipbuilding.*) 1. Radiating cant-frames, abaft the fashion-pieces and below the wing-transom, stepped partly on the dead-wood and partly on stepping-pieces bolted to the sides of the inner stern-post.

2. Those abaft the midship section.

Ag'a-ba'nee. (*Fabric.*) Cotton embroidered with silk, made in Aleppo.

Ag'ate. (*Printing.*) 1. A size of type between Pearl and Nonpareil; called Ruby in England.

Pearl.
Agate, or Ruby.
Nonpareil.

2. The draw-plate of the gold-wire drawers; so called because the drilled eye is an agate.

3. The pivotal cup of the compass-card.

Age'ing. (*Pottery.*) The storage of prepared clay, to allow it time to ferment and ripen before using. The *slip*, consisting of levigated clay and flint, is run in a thin solution through sieves and brought to a creamy consistence. This is boiled down to give it more solidity, and is then stored away, sometimes for years, being occasionally cut out in chunks and slapped to expel air and develop the plasticity. During the *ageing* process a slight fermentation occurs, carbonic acid and sulphureted hydrogen are disengaged, and the mass is improved in texture and quality. The clay is thus allowed to temper in cellars or under cover, sometimes for several years.

In China, a potter prepares the clay for the succeeding generation while working up that bequeathed to him by his ancestors.

(*Wine and Liquors.*) Devices for this purpose subject the liquid to heat and agitation; some of them using the combined action of heat, electricity, and attrition. See WINE-AGEING APPARATUS.

(*Calico Printing.*) The exposure of printed calicoes in a sufficiently moist and warm air to allow the colors to permeate and mature. An apparatus was patented by Thom, England, for applying air loaded with moisture of a given temperature to the printed fabric, which is then folded and allowed to rest for a few hours in that condition.

A-gist'ment. A dike or embankment to prevent the overflow of land abutting upon a stream or the sea.

Ag'i-ta'tor. A rotating beater or armed shaft for mixing and disturbing articles mechanically suspended in water, such as

The *pulp* in the stuff-chest of a paper-machine.

The *mash* in the mash-tub of a brewery.

The mixture of starch, sugar, etc., and water, in the washing process of starch-making.

Ag'ri-cult'ur-al Im'ple-ments. These are treated, as fully as the limits will permit, under their respective heads; it is needless to repeat here the history of their progressive development or the order of their succession. See the following, under their respective heads: —

AGRICULTURAL AND HUSBANDRY IMPLEMENTS, ETC.

Aberuncator.
Animal-clutch.
Animal-poke.
Apiary.
Atmospheric churn.
Auger. Earth-boring.
Aveler.
Averuncator.
Awner.
Bagasse-dryer.
Bag-fastener.
Bag-holder.
Bag-tie.
Bale-tie.
Baling-press.
Band for baling.
Band for binding grain.
Band-cutting machine.
Barking-tools.
Barley-chumper.
Barley-fork.
Barley-huller.
Bar-share plow.
Basket.
Bean-harvester.
Bean-mill.
Bee-feeder.
Bee-fumigator.
Beehive.
Beehive, swarm-indicator for
Bee-tax.
Belly-roll.
Bill.
Bill-hook.
Binder.
Binding attachment for harvesters.
Binot.
Blade.
Bob-sled.
Bog-cutting plow.
Bott-hammer.
Bow. Ox
Braking-machine.
Branding-tool.
Breast-plow.
Brier-scythe.
Broach.
Broadcast-sower.
Bruising-machine.
Brush-puller.
Buggy-cultivator.
Bull-nose ring.
Bush-harrow.
Bush-scythe.
Butter-mold.
Butter-tongs.
Butter-worker.
Calorifier.
Cane-harvester.
Cane-scraper.
Cane-stripper.
Cattle-feeder.
Cattle-leader.
Cattle-pump.
Cattle-stall.
Cattle-tie.
Caving-rake.
Chaff-cutter.
Cheese-cutter.
Cheese-hoop.

Cheese-knife.
Cheese-shelf.
Cheese-vat.
Chessel.
Chicken-raising apparatus.
Chopness.
Chopper.
Churn.
Churn-dasher.
Churn-power.
Cider-mill.
Cider-press.
Clevis.
Clod-crusher
Clover-harvester.
Clover-huller.
Clover-thrasher.
Clutch for catching animals.
Cockle-separator.
Colter.
Corn-coverer.
Corn-crib.
Corn-cultivator.
Corn-cutter.
Corn-harp.
Corn-harvester.
Corn-huller.
Corn-husker.
Corn-husk splitter.
Corn-knife.
Corn-planter.
Corn-plow.
Corn-row marker.
Corn-sheller.
Corn-shocking machine.
Corn-stalk cutter.
Corn-stripping knife.
Cotton-brush chopper.
Cotton-chopper.
Cotton-cultivator.
Cotton-gin.
Cotton-picker.
Cotton-press.
Cotton-scraper.
Cotton-seed cleaner.
Cotton-seed planter.
Cotton-seed preparing.
Cotton-topper.
Cow-milker.
Cradle.
Cranberry-gatherer.
Cream slice.
Croom.
Cultivator.
Cultivator plow.
Curculio-trap.
Curd-breaker.
Curd-cutter.
Cutter. Harvester
Cutting-box.
Diamond plow.
Dibble.
Dibbling-machine.
Digger.
Digging-machine.
Ditching-machine.
Ditching-plow.
Ditching-tools.
Double plow.
Double-mold-board plow.
Double shovel plow.
Drag.
Draining-plow.
Drill. Barrow.
Drill. Grain.
Drill. Harrow.
Dropper.
Dumping-reel.
Dung-fork.
Dung-hook.
Edging shears.
Egg-hatching apparatus.
Expanding plow.
Fanning-mill.
Feed-bag.
Feed-cutter.
Feed-rack.
Fence.
Fence-jack.
Fence-post.
Fence-post driver.
Fertilizer-sower.
Fiddle.
Finger.
Flail.
Flax-brake.
Flax-puller.
Flax-scutcher.
Flax-thrasher.
Flax-washer.
Fleece-folder.
Flower-pot.
Fork.
Fork. Horse hay-
Fruit-dryer.
Fruit-frame.
Fruit-gatherer.
Fruit-ladder.
Fruit-picker.
Fruit-preserving house.
Fruit-press.
Fumigator.
Furrowing-plow.
Gage wheel.
Gallows.
Gang-cultivator.
Gang-plow.
Garden ladder.
Garden shears.
Garden syringe.
Garlic-separator.
Gate.
Gate-post.
Gaveling attachment for harvesters.
Grafting-chisel.
Grain-binder.
Grain-bruiser.
Grain-cleaner.
Grain-conveyer.
Grain-cradle.
Grain-drill.
Grain-dryer.
Grain-fork.
Grain-harvester.
Grain-rake.
Grain-sacker.
Grain-screen.
Grain-separator.
Grain-shovel.
Grain-thrasher.
Grain-wheel.
Graip.
Granary.
Grapery.
Grape-trellis.
Grass-harvester.
Grass-seed separator.
Ground auger.
Grubber.
Grubbing-axe.
Grubbing-hoe.
Guard finger.
Hackling-machine.
Hair-clipping shears.
Hand-cultivator.
Hand-planter.
Harle.
Harrow.
Harvester rake.
Harvesting-machine.
Hasp.
Hay-band machine.
Hay-cutter.
Hay-fork.
Hay-knife.
Hay-loader.
Hay-press.
Hay-rack.
Hay-rake.
Hay-raker and cocker.
Hay-spreader.
Hay-stacker.
Hay-tedder.
Hay-unloader.
Heading-machine.
Hedge-planter.
Hedge-clipper.
Hedge-shears.
Hedging tools.
Hemp-brake.
Hemp-harvester.
Hen's-nest.
Hink.
Hive.
Hoe.
Hoe. Horse.
Hoe-plow.
Hog-elevator.
Hog-hook.
Hog-nose-trimmer.
Hog-ring.
Hog-scalding tub.
Honey-strainer.
Hop-frame.
Hopple.
Hop-pole.
Hop-press.
Horse hay-fork.
Horse-hoe.
Horse-power.
Horse-rake.
Horseshoe.
Hot-bed frame.
Humbug.
Hummeling machine.
Hurdle.
Husker.
Husking-peg.
Incubator.
Insect-exterminator.
Insect trap.
Jumper.
Kibbling-machine.
Lactometer.
Lactoscope.
Ladder.
Land-paring machine.
Lap-ring.
Lard-cutter.
Lard-renderer.
Lawn-mower.
Layering implements.
Leveler.
Lime-spreader.
Manger.
Manure-drag.
Manure-drill. Liquid
Manure-fork.
Manure-hook
Manure-loader.
Manure-spreader.
Marking-plow.
Mattock.
Maul.
Milk-can.
Milk-cooler.
Milking apparatus.
Milk-rack.
Milk-shelf.
Milk-strainer.
Milk-vat.
Mole-plow.
Mollebart.
Moth-trap.
Mower.
Muck-fork.
Muck-rake.
Muzzle.
Nib.
Osier-peeler.
Ox-shoe.
Ox-yoke. (See Yoke.)
Paring-plow.
Peanut-digger.
Pea-rake.
Peat-machine.
Peeling-iron.
Pickaxe.
Picker. Cotton
Picket.
Pitchfork.
Planter.
Plow (varieties; see Plow).
Plow-cleaner.
Poke.
Portable fence.
Post-auger.
Post-driver.
Post-hole borer.
Post-hole digger.
Post-jack.
Post-puller.
Potato-digger.
Potato-hook.
Potato-planter.
Potato-scoop.
Potato-separator.
Poultry-feeder.
Powder-blower.
Prairie-plow.
Propagating-box.
Pruning-shears.
Pruning-tools.
Rack.
Rake.
Raker and loader.
Rake-harvester.
Rake. Horse hay.
Reaper.
Reaping-hook.
Reaping-machine.
Reel. Harvester
Reversible plow,

Rice-cleaner.
Riddle.
Ridging-plow.
Ripple.
Roller. Land
Root-bruiser.
Root-cutter.
Root-digger.
Root-grinder.
Root-washer.
Rotary cultivator.
Rotary digger.
Rotary harrow.
Rotary plow.
Rotary spader.
Rudder.
Sap-bucket.
Sap-bucket hook.
Sap-spile.
Scarifier.
Scoop.
Scraper.
Scuffle-hoe.
Scuffler.
Scythe.
Seed-drill.
Seeding-machine.
Seeding-plow.
Seed-planter.
Seed-sower.
Separator.
Share.
Shears. Pruning
Shears. Sheep.
Sheep-dipping apparatus.
Sheep-foot trimmer.
Sheep-holder.
Sheep-rack.
Sheep-shearing machine.
Sheep-shearing table.
Sheep-shears.
Sheep-washing apparatus.
Sheller. Corn
Shovel.
Shovel plow.
Sickle.
Side-hill plow.
Single-shovel plow.
Skeleton plow.
Skid.
Skim-colter plow.
Skinning apparatus.
Slaughtering apparatus.
Smoke-house.
Smut-machine.
Snath.
Snouter.
Snout-ring.
Snow-shovel.
Sod-cutter.
Sod-plow.
Sorghum-evaporator.
Sorghum-stripper.
Sower.
Spade.
Spading-machine.
Spud.
Stable-cleaner.
Stack-borer.
Stacker.
Stacking derrick.
Stack-stand.
Staddle.
Stalk-cutter.
Stalk-puller.
Stall.
Steam-engine. Agricultural
Steam-plow.
Stock-feeder.
Stocks for refractory animals.
Stone-boat.
Stone-gatherer.
Straddle-plow.
Straw-carrier.
Straw-cutter.
Stubble-turner.
Stump-extractor.
Subsoil plow.
Sugar-cane planter.
Sulky plow.
Sward-cutter.
Swather.
Sweet-potato cultivator.
Swing-moldboard plow.
Swing plow.
Tedder.
Tether.
Thatching.
Thistle-digger.
Thrasher.
Tobacco-curing apparatus.
Tormentor.
Track-clearer.
Transplanter.
Treble-shovel plow.
Tree-digger.
Tree-protector.
Tree-remover.
Tree-scraper.
Trellis.
Trowel.
Turf-cutter.
Turnip-puller.
Turnwrest plow.
Vegetable-chopper.
Vegetable-slicer.
Vegetable-washer.
Weeding-hoe.
Wheel-colter
Wheel-cultivator.
Wheel-plow.
Whitening-machine.
Willow-peeler.
Winnowing-machine.
Wool-packer.
Wool-packing table.
Wool-press.
Yoke.

Ag'ri-cult'ur-al Steam'-en'gine. A steam-engine specifically adapted for use in thrashing and some other farm operations. Its principal peculiarity consists in compactness and portability. See PORTABLE STEAM-ENGINE.

Aich's Met'al. An alloy of copper, zinc, and iron, used for guns. Patented in England, February 3, 1860, by Johann Aich, Imperial Arsenal, Venice. It is composed as follows: —

Copper,	60.
Zinc,	38.125
Iron,	1.5

It resembles the Keir metal, English patent, December 10, 1779, which has, —

Copper,	100	or,	100
Zinc,	75		80
Iron,	10		10

Also the sterro-metal of Rosthorn, Austria, 1861, which has, —

Copper,	55.04	or,	57.63
Tin,	0.83		0.15
Zinc,	42.36		40.22
Iron,	1.77		1.86

Austrian navy brass has, —

Copper,	60.
Zinc,	38.12
Iron,	1.8

Chinese Packfong has, —

Copper,	40.04
Zinc,	25.4
Iron,	2.6
Nickel,	31.6

See ALLOY.

Ai'guille. A needle. Among masons, a stone-boring tool. A priming-wire.

Aim-front'let. A piece of wood hollowed out to fit the muzzle of a gun, so as to make it level with the breech, formerly in use among gunners. Wooden front-sights on a similar principle are still used on board ship in case of emergency, as when an accident occurs to the proper metal sights.

Air and Steam En'gine. See AËRO-STEAM ENGINE.

Air Appliances and Machinery.

Acetifier.
Acoustic instruments.
Acoustic telegraph.
Æolus.
Aërator.
Aërial railway.
Aëro-hydro-dynamic wheel.
Aërostat.
Aëro-steam-engine.
Air and steam engine.
Air as a means of transmitting power.
Air as a water-elevator.
Air-bath.
Air bed and cushion.
Air-blast.
Air-brick.
Air-carbureting.
Air-casing.
Air-chamber for pumps.
Air-compressing machine.
Air-cooling apparatus.
Air-cushion for pipes.
Air-drain.
Air-drill.
Air-engine.
Air-escape.
Air-exhauster.
Air-filter.
Air-fountain.
Air-grating.
Air-gun.
Air-heater.
Air-holder.
Air-jacket.
Air-level.
Air-lock.
Air-machine.
Air-meter.
Airohydrogen blow-pipe.
Airometer.
Air-pipe.
Air-poise.
Air-pressure filter.
Air-pump.
Air-regulator
Air-scuttle.
Air-shaft.
Air-spring.
Air-stove.
Air-thermometer.
Air-trap.
Air-trunk.
Air-tube for conveyance.
Air-valve.
Air-vessel.
Anemograph.
Anemometer.
Anemoscope.
Aspirator.
Atmospheric alarm.
Atmospheric churn.
Atmospheric engine.
Atmospheric governor.
Atmospheric hammer.
Atmospheric railway.
Atmospheric spring.
Atomizer.
Auricle.
Balloon.
Bellows.

Blast.
Blast-machine.
Blast-nozzle.
Blower.
Blowing-machine.
Blowing-tube.
Blow-pipe.
Caloric engine.
Captive balloon.
Carbonic-acid engine.
Carbureting-machine.
Car-ventilator.
Cold-blast.
Compressed-air engine.
Cupping-pump.
Cylinder blower.
Detonating tube.
Dispatch-tube.
Diffusion-tube.
Disinfecting apparatus.
Ear. Artificial
Ear cornet.
Ear instruments.
Ear-trumpet.
Eccentric fan-blower.
Ejector.
Eudiometer.
Exhaust fan.
Fan.
Fan-blower.
Fanner.
Fanning-machine.
Fanning-mill.
Fan-ventilator.
Fire-extinguisher.
Flighter.
Flying-machine.
Foot-bellows.
Fumigator.
Graduator.
Gunpowder engine.
Hydrostatic bellows.
Inhaler.
Insect exterminator.
Insufflator.
Leech. Artificial
Life-preserver.
Magdeburg hemispheres.
Mulguf.
Organ.
Parachute.
Pneumatic drill.
Pneumatic lever.
Pneumatic pile.
Pneumatic pump.
Pneumatic railway.
Pneumatic spring.
Pneumatic trough.
Pneumatic tube.
Pneumatic tubular dispatch.
Pneumatic valve.
Pneumatometer.
Punkah.
Respirator.
Rotary blower.
Rotary fan.
Sand-bellows.
Sand-blower.
Screw ventilator.
Sirene.
Smoke-jack.
Sonifer.
Sonometer.
Sound-board.
Speaking-tube.
Speaking-trumpet.
Spirometer.
Stench-trap.
Thermometric ventilator.
Tonometer.
Torricellian vacuum.
Trompe.
Tuyere.
Vacuum apparatus.
Vacuum-filter.
Vacuum-gage.
Vacuum-pan.
Vacuum-pump.
Vane.
Ventilating millstones.
Ventilator.
Water-bellows.
Wind-car.
Wind-chest.
Wind-cutter.
Wind-furnace.
Wind-gage.
Windmill.
Windmill-propeller.
Wind-pump.
Wind-sail.
Wind-trunk.
Wind-wheel.

Air as a Means of transmitting Power. So far as our information extends, the first person to use compressed air as a means of transmitting power was that ingenious Frenchman, Dr. Papin of Blois, about A. D. 1700. We shall have occasion to refer to him in the History of the Steam-Engine. He was the first to apply a piston in the steam-cylinder, and was the inventor of the digester, and the steelyard safety-valve, — the best and simplest effective form yet devised.

Papin used a fall of water to compress air into a cylinder, and led it thence by a pipe a distance of a mile. Having reached its destination, it was employed to drive a piston in a cylinder, the power being intended to work a pump. The distance, the friction, and the leakage were too much for the Doctor, and the inversion of the process, making the primary engine exhaust instead of condensing, had no better effect. Thinking that it was the volume of air in the pipe which made the second cylinder unresponsive to the action of the primary cylinder, he reduced the size of the pipe, but still the pumping-machine would not move. In Auvergne and Westphalia the project was tried on an extensive scale, attempts being made to drain mines by these means.

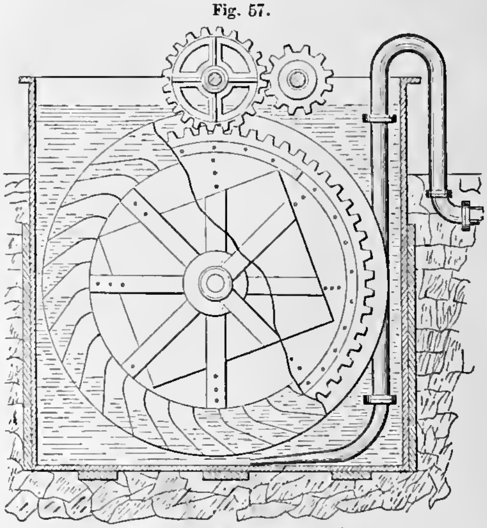
About one hundered years after the experiment of the philosopher of Blois, a Welsh engineer used the power derived from a heavy fall of water to work a blowing-cylinder from which air was conveyed to a blast-furnace a distance of a mile and a half. The resulting blast was feeble.

Some forty years since, a Mr. Hague took out an English patent for the application of compressed air to working-cranes, hoisting-machines, and other machinery. The air was compressed by an air-pump at a central location, and the air conducted by pipes to the cranes and other machinery of a series of docks and warehouses.

The same inventor also applied an air-exhaust to raising a tilt-hammer. See ATMOSPHERIC HAMMER.

The subjoined cut has a remarkably unpromising look, but must not be condemned because it resembles at first sight one attempt at the chimerical and impossible "perpetual motion."

Fig. 57.



Calles's Aëro-hydro-dynamic Wheel.

It is one mode of transmitting power by means of condensed air.

The following is from the Journal of the Society of German Engineers, and describes the apparatus represented in the cut, the invention of M. Calles of Belgium: —

"It consists mainly of a wheel adapted with buckets similar to those in an ordinary water-wheel, and completely immersed in a tank filled with water. This wheel carries a toothed inner rim, which works a pinion adapted to the transmission-shaft.

"Most transient visitors to the Paris Exposition, as they walked past this contrivance, hardly gave it a look, believing that it was the pinion that gave motion to the wheel, and considered it as some sort of stirring or washing machine; but the inverse was in reality the case, as it was the immersed wheel which gave motion to the pinion by the direct action of slightly compressed air.

"The general disposition of parts will be readily understood by reference to the diagram: —

"The diameter of the wheel exhibited was 9 feet; its breadth 4½. It carried 30 buckets, curved in such a manner that 13 of them (figured to the left) always retained a certain quantity of air in their upper portion.

"The air was introduced under the bottom of the wheel, through a curved pipe. The air thus blown into the buckets had naturally a tendency to gain the surface of the water with a force equivalent to the weight of displaced water, and this upward tendency caused the rotation of the wheel, and at the same time brought back the discharged buckets successively before the orifice of the tuyere.

"The wheel made six revolutions per minute, so that three buckets were filled with air every second.

"The air rushed with a velocity of 32 metres per second through a pipe 0.095 metres in diameter. The quantity discharged was consequently 0.227 cubic metres per second, equivalent to 0.075 cubic metres for each bucket or cell. During every second of time, 13 buckets were thus partly filled with air, their total capacity being 0.983 cubic metres. The same bulk of water being displaced, a constant power of approximately 983 kilogrammes, or 2,163 lbs., per second was obtained.

"The internal diameter of the wheel being 2.26 metres, its annular surface 3.05, and its width 1.5, it is readily computed that the 30 buckets occupied a space of 4.585 cubic metres, and that each cell cubed 0.153 cubic metres, — a portion of which space, equivalent to one half, or to 0.075, alone contained air.

"If the application of force be supposed to have been applied at one quarter of the depth of the wheel under water as an average, then the speed of any point of its surface would have been $2.445 \times 6 \times w \div 60 = 0.77$ metres = 30 inches.

"Multiplying this speed by the 983 kilogrammetres, we find the power transmitted per second to have amounted to 757 kilogrammetres. If we deduct herefrom 20 per cent for losses by friction, reaction of water, etc., there remain 606 kilogrammetres, or 260,000 foot-pounds, as available working-power per minute, — equivalent to an 8-horse power.

"The forcing of the air was effected by means of a 9½-horse steam-engine, — the compression of the air being one quarter of an atmosphere. In the example exhibited, 83 per cent of the power of the engine was thus transmitted to the wheel, and this through a pipe 510 feet long and presenting 14 elbows.

"The above-described new method of transmission of motion may prove of very great value in many situations where the application of belts and shafting, parallel motions, such as are used in mines, and other similar contrivances, is impracticable. It might also be applied with success to the driving of machinery in cities for the smaller branches of industry, — the compressed air in such a case being conveyed through mains and pipes laid below the surface of the streets in the same manner as is at present practised for our water and gas supplies."

By reference to Wire Rope, several instances may be found where power is transmitted to a distance much beyond what is possible with belting or shafting, the ordinary expedients. In one case, at Frankfort on the Main, the power is thus transmitted 3,200 feet. In a second case, at Schaffhausen, in Switzerland, the power of a number of turbines, amounting in the aggregate to 600-horse power, is transmitted more than a mile, crossing the river Rhine to the place where the power is to be distributed.

Machinery in mines and tunnels is frequently driven by the power of compressed air, which is condensed into a reservoir by steam or water power on the surface of the ground, and conducted by pipes to the deep-seated spot where the drill or mining-machine is at work.

"At Mont Cenis the air-pipes must be as much as five miles in length, and the loss of pressure is not such as to impair the working of the drills; but I am without accurate information as to its extent. At Hoosac they are one and a half miles long, and the loss is two pounds to the square inch. At Nesquehoning they are one third of a mile in length, and there is no appreciable loss of pressure. In this case the air is worked at about fifty pounds per square inch; and the difference in pressure at the steam-valves, when the power is generated, and the air after it is compressed, may be taken at about ten per cent when the best compressors are used. It will then be seen that the loss of power from the friction of the compressing machinery, and from the movement of air in the pipes, is not of a very serious character, and, if the pipes are tight, the pressure is well maintained while the machinery is standing." — *Steele.*

"The compression of the air by which the drills at the Hoosac Tunnel are driven is effected at the east end of the tunnel by water-power; four 20-horse turbines being employed, which operate sixteen air-pumps, each of 13½-inch bore and 20-inch stroke.

"The air is compressed to 65 pounds to the square inch, or a little over four atmospheres, and conducted through an 8-inch cast-iron pipe to the drills at the tunnel heading, where branch pipes connect several drill-cylinders with this 8-inch pipe. With six of the drills at work and making 250 strokes per minute, the gage on the air-pipe at the heading of the tunnel shows a pressure of 63 pounds against 65 pounds at the pump-rooms, one mile and a half distant."

"The engineers of the Mont Cenis Tunnel have expressed themselves strongly in favor of the view that the plan is truly economical, and as their experience in the use of this form of applying power has been larger than any which has been elsewhere enjoyed, their statements deserve consideration. At the date of the report on the progress of the work in the tunnel during the year 1863, they were engaged at a distance of nearly two thousand metres from their reservoirs of condensed air, and were driving nine borers with a force of 2½-horse power each. The tube conveying the air to the perforators was two decimetres (nearly eight inches) in diameter. The air was under a pressure of six atmospheres, and its velocity in the tube was nine decimetres (three feet) per second. The transmission of the power to this distance, and under these conditions, was attended with no sensible loss. The pressure was not perceptibly less at the working extremity of the tube when all the perforators were in operation than when the machinery was entirely at rest.

"A series of experiments was instituted in 1837, by order of the Italian government, to determine the resistance of tubes to the flow of air through them. These experiments were made previously to the commencement of the work upon the tunnel, and while the feasibility of employing compressed air to furnish the motive-power of the boring apparatus was considered still questionable. It was the aim of the investigation not merely to ascertain the absolute loss of force occurring in the transmission of air through tubes of certain particular dimensions, but to determine, if possible what are the *laws* which govern the variations of resistance, when the velocities of flow and the diameters of the tubes are varied. From the results of the experiments were deduced the three conclusions following, namely, —

"I. The resistance is directly as the length of the tube.

"II. It is directly as the square of the velocity of flow.

"III. It is inversely as the diameter of the tube." See *Report of Dr. Barnard, United States Commissioner at the Paris Exposition.*

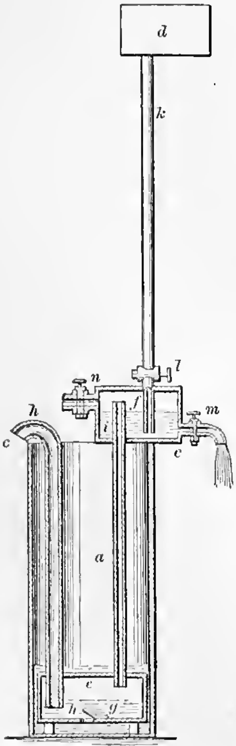
This great work is happily completed. See TUNNEL.

In the Verpilleux pump, water is made the means of transmitting power. See FORCE-PUMP.

The transmission of power by means of compressed air has now become an established fact, notwithstanding the clear decision which was rendered against it, from the supposed nature of the case and the principles involved. Its use in the Hoosac and Mont Cenis Tunnels in driving the boring-machines is referred to under TUNNEL. Its use in the Govan Colliery, Scotland, is referred to under AIR-COMPRESSING MACHINES. See also AIR-ENGINE, COMPRESSED. Its use as a liquid elevator is considered in the next article.

Air as a Water Elevator, Compressed. The first attempt to raise water by the pressure of a body of compressed air, so far as our present information extends, was that by Dr. Papin, of Blois, France, about 1695. His experiments were particularly directed to utilizing the power of a fall of water in compressing air which was conveyed a mile or more to a cylinder at the mine, where it was intended to work a pump by reciprocating a piston in the manner of a steam-engine. The experiment failed, as has been already stated (see AIR AS A MEANS OF TRANSMITTING POWER), but has since been successful in operating rock-drills at Hoosac Mountain, Mont Cenis, and many other places.

Fig. 58.



Chemnitz Water-Elevator.

It does not appear that Dr. Papin tried the direct pressure of a body of air upon the water; in a manner similar to the pressure of steam upon the surface of the water in the *so-called* steam-engines of Baptista Porta, 1600; De Caus, 1620; Marquis of Worcester, 1655; Savery, 1698. See STEAM-ENGINE.

For many years past — probably a century or more — water-elevators operating by condensed air have been used at the mines of Chemnitz in Hungary. A high column of water is used to condense a column of air in a pipe, so that the power of the apparatus is proportioned to the vertical height of the fall which is available. In the mountainous districts of Central Europe some remarkable falls are thus utilized, some of which are referred to under TURBINE. In the Black Forest of Baden turbines are running with falls of 72 and 354 feet, and having diameters of from 20 to 13 inches respectively.

In the figure, the vertical elevation is out of all proportion small, but the principle involved is not affected thereby. It should be understood that the height of the fall above the surface of the ground should be as great as the depth below the surface of the ground of the water to be elevated. If the fall be in excess of the lift, so much the better.

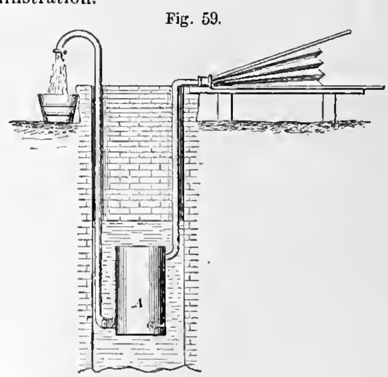
a is the shaft of the mine, and *c* the surface of the earth; *d* is the penstock of the water at the top of the fall, and *k* the pipe which leads the water to the air-tight box *f* at the surface of the ground. The closed box *f* communicates by an air-pipe with the air-tight box *e* which is submerged in the *sump-hole* at the bottom of the mine. The eduction water-pipe *h* has its lower end submerged in the water of the box *e*, and conducts the water to the surface *c* when the apparatus is in action. A cock *l* in the fall-pipe *k* is closed or opened as the alternating to be described requires. The box *f* has also cocks at *m* and *n*, and the box *e* an inlet valve *g* on its bottom.

The operation is as follows: —

The cocks *l* and *m* being closed, the cock *n* is opened to allow the air to escape from box *e* and the water to flow thereinto by the valve-way *g*. The cock *n* is then shut, the water-cock *l* opened, when the column of water in the pipe *k* will fill the chest *f*, expelling the air therein and driving it down the pipe *i* into the box *e*, expelling the water therefrom to a certain extent, that is, until the pressure of the condensed air in the box *e* is equalled by the weight of the vertical column in the discharge-pipe *h*; which should have a valve at its lower end opening upwardly. The cock *l* is now closed and the cock *m* opened, allowing the water to run out of the box *f* and the air from *e* to fill box *f*, while water enters the lower box by valve-way *g*. The cock *m* being closed and the cock *l* opened, the air is again forced from *f* into *e*, repeating the process just described.

An early example of raising water by the dejection of a condensed body of air is the patent of UPHAM, January 6, 1809, of which the annexed cut is an illustration.

Fig. 59.

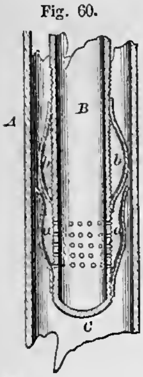


Upham's Pump.

Pressure on the bellows injects a body of air into the chamber *A* in the well, and drives a body of water from thence through the eduction-pipe which leads to the discharge above the surface of the ground. When the bellows is raised, the valve at the foot of the eduction-pipe closes and water enters the chamber by the induction-valve. The repetition of the motion again ejects water, and so on. The required degree of pressure in the air-chamber is attained by means of an air-valve in the bellows; after that, if the level of the water remain the same, the same body of air is made the agent, by its vertical pulsations, of ejecting the water.

The use of compressed air in forcing liquids from deep wells or shafts has received a great accession from the oil enterprises in Western Pennsylvania and other places.

Fig. 60.



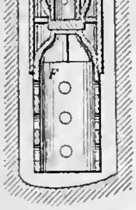
Mowbray's Ejector.

Perhaps as many as fifty patents have been granted for various forms of EJECTORS, the different forms of which will be considered under that title. These are founded on the same principle as the Giffard injector, which is a favorite device for boiler supply. In the ejectors an annular stream of fluid under compression (air or steam) is emitted around an axial nozzle communicating with the liquid to be moved; or, conversely, a central stream of compressed fluid to propel a film of liquid through an annular opening.

In the deep oil-wells, which consist of a vertical shaft of a few inches' diameter and several hundred feet depth, it is advisable to have all the apparatus included within a single tube as in the two following cases:—

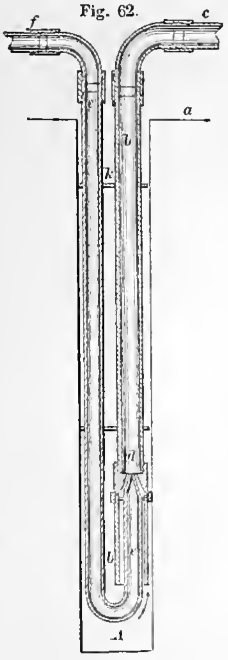
MOWBRAY, December 13, 1864. The current of compressed air from the engine above descends the middle pipe B, and is emitted at the annular opening between the cup a and the bulb b on the central pipe. The area of the annular opening is adjustable, and the effect of the emission of the stream of compressed air is to draw up the liquid from the space C, and elevate it to the surface through the space intervening between the tubes B and A.

Fig. 61.



Angier and Crocker's Ejector.

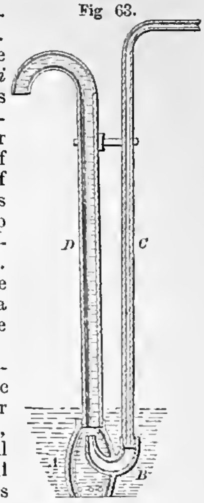
Fig. 62.



Angier and Crocker's Ejector.

ANGIER AND CROCKER, December 13, 1864, have a device for the same purpose. Fig. 61 shows a section of the well in which the seed-bag i (see WELL-TUBE PACKING) is shown. Its purpose is to prevent the descent of the water from above to the bottom of the well whence the supply of oil is drawn. The bulbous deflector and encircling cup are arranged for action as described in the preceding case. B is the air-descending, A the oil-ascending space. F is a perforated tubular foot for the well-tube.

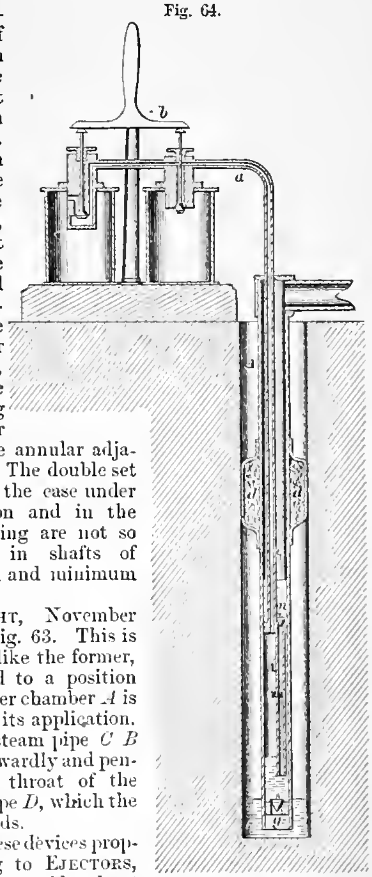
Fig 63.



McKnight's Water-Raiser.

ANGIER AND CROCKER, October 11, 1864. Fig. 62. The current of compressed air passes down the tube f c, whose lower end is recurved upwardly and ends in a small orifice at which the air is emitted. As the air passes through the throat d into the pipe b, it tends to produce a partial vacuum in its rear, and draws an annular film of water with it from the space A at the bottom of the well. The action is the same as in the former case, except that in this the moving fluid is a jet central to the film of water moved by it, and in the preceding cases the air and oil were annular adjacent films. The double set of pipes in the case under consideration and in the next following are not so convenient in shafts of great depth and minimum diameter.

Fig. 64.



Pease's Oil-Ejector.

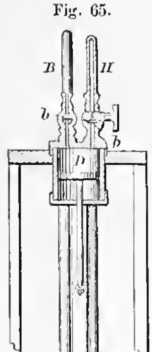
McKNIGHT, November 1, 1864. Fig. 63. This is an ejector like the former, but adapted to a position where a lower chamber A is not fatal to its application. The air or steam pipe C B recurves upwardly and penetrates the throat of the eduction-pipe D, which the water ascends.

While these devices properly belong to EJECTORS, which are considered at greater length under that title, it will be useful to give a slight sketch of the modes of utilizing the compressed air, the subject-matter of this article.

The ejectors described are direct-acting and the pressure continuous. It remains to cite one or two employing the pulsative or alternate action of air. This is accomplished by alternate pressure and exhaust, and is claimed to be very effective.

PEASE, March 28, 1865. The current of air is made to oscillate in the downcast tube, acting like an elastic piston in its effects upon the contents of the chamber A', which is placed low down in the well A. Fig. 64. The upper end of the pipe is connected alternately with two cylinders, in one of which is a body of compressed air, while in the other is a partial vacuum; the exhaust and pressure of the respective vessels being effected by an air-pump. The rock-bar *b* is oscillated on its pivot, and acts alternately upon the valves, bringing the pipe *a* in connection with the pressure and exhaust in turn, and giving the pulsative movement to the column of air in the pipe. As the air rises therein, the induction-valve *g*, at the foot of the chamber, lifts and admits oil from the well to the chamber A', and as the column of air descends, the said valve closes and the oil is raised through the pipe *m*, the valve *n* rising to allow it to pass to the upward discharge-pipe *c*. The seed-bag *d* acts as a packing between the exterior pipe and the wall of the well, and prevents access of water from fissures to the water, oil, or brine at the bottom of the well.

Fig. 65.



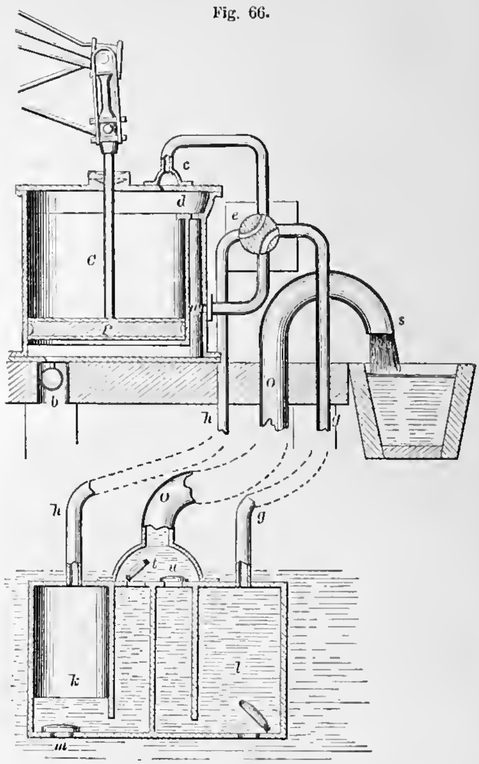
Woodward's Air-Pump.

WOODWARD, May 30, 1865. The piston reciprocates in the air-cylinder, and by adjustment of the valves *b b*, is the means of exhausting from the chamber *A* or of forcing air into the said chamber. As the air is withdrawn, the chamber is filled by the induction-pipe, the valve *a* opening for that purpose. When the air is compressed into the chamber, the water is ejected by the pipe *B*. The action is not pulsative, as in the preceding case, but is alternate by the operation of the same cylinder and piston, and is effected by changing the position of the cocks *b b*.

A Hydraulic Engine, so called, patented in England by Seidler some forty years since, may be classed among the alternate-acting water-elevators operated by compressed air. The construction will appear by reciting the series of operations when it is in action. Supposing the piston *P* to commence its upward stroke, the air in the cylinder *C* will be driven through the valve *c* in the upper head and by means of the pipe *h* into the submerged vessel *k*, forcing the water contained therein through the valve-way *t* and by means of the eduction-pipe *O* to the discharge-chute *s*. Air will be supplied to the cylinder below the piston by the opening of the valve *b*.

When the piston descends, the air will pass from the lower to the upper side of it by means of the valve *d*, and the operation will be continued till the water is driven out of *k*, when the two-way cock *e* will be turned to change the communication; the air then passing by pipe *g* to the tank *l*.

Fig. 66.



Seidler's Engine.

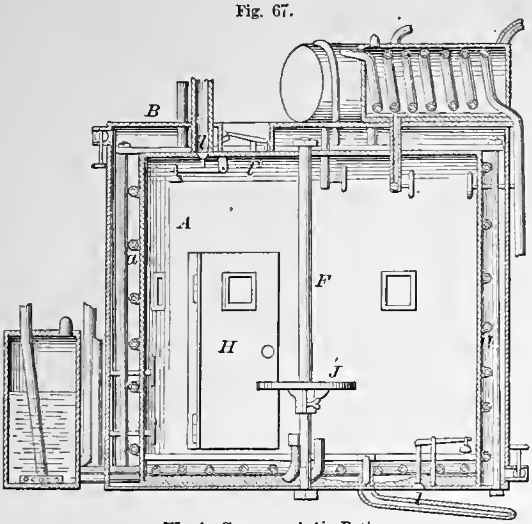
The air which was forced into *k* is permitted to re-enter the cylinder through the pipe *w*, as shown by the dotted lines in the cock *e*, so that no air will be required to enter at the valve *b* except at the commencement of the operation, or to make up for any air lost by leakage or discharged with the water. When the air is liberated from the tank *k*, it is again filled with water by the valve *m*, the valve *t* being shut by the pressure of water in the pipe *O*. While this is proceeding, the water is being discharged from the tank *l* by the valve-way *u* into the pipe *O*, as before described in relation to the tank *k*. The cock *e* is turned by hand or by machinery, after such a number of strokes as may be sufficient to empty a division of the tank.

Air'-bath. A therapeutic apparatus for the application of air to the body, in a jet or chamber, locally or generally, refrigerated or heated.

The compressed-air apparatus is the reverse of the vacuum appliance, which proposes to increase the surface secretion and local circulation by exhausting air; an operation analogous to *dry cupping*. See DEPURATOR.

WARE'S Compressed Air-bath is for subjecting a patient to an enveloping atmosphere of air under pressure. The chamber *A* has a non-conducting outer wall *B*, and a metallic inner wall, the intervening space being occupied by coils of pipe *a*, which may be steam-heated. A safety-valve in the floor limits the pressure. *H* is the door of entrance, which shuts air-tight. The patient has command of the air and steam valves by which the chamber is charged and the steam-coil heated. J' is a seat, *F* a tie-rod, *l* an eduction water-pipe.

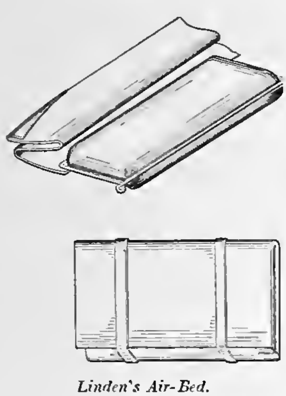
Fig. 67.



Ware's Compressed Air-Bath.

Air-bed and Air-cush′ion. These were known in the beginning of the eighteenth century, and were at first made of leather and afterward of air-tight or Mackintosh cloth ; at present they are made of vulcanized india-rubber. The bed is a sack in the form of a mattress, divided into a number of air-tight compartments, and having a projection at one end forming a bolster ; each compartment has a valve through which it is inflated by a bellows. Air-cushions are merely small sacks filled with air through a tube at one corner or end, by means of an air-condenser or by expiration from the lungs : escape is prevented by a screw-stopcock. These articles are useful to travellers and invalids, being light and elastic, but are liable to be torn or punctured, and thus rendered worthless.

Fig. 68.



Linden's Air-Bed.

Linden, October 7, 1862, has adapted the elastic bed to be used as a part of the infantry equipment. The air-bed has an outside flap of enamelled cloth or leather, cut longer and wider than the bed so as to form a coverlid for the person who lies upon the inflated bed. When the bed is collapsed it can be folded in such a manner as to form a knapsack, and is provided with straps to enable it to be worn as such when on the march.

Hamilton, July 16, 1867, ties the upper and lower surfaces of the bed, of air-proof material, by means of cords which are secured to button-headed screws and cap-nuts, which clamp the material and make the joint air-tight.

Gilbert, February 11, 1868, stuffs the beds with elastic, hollow spheres of rubber. The same device was employed by a patentee in England, whose bed is described in the English Cyclopædia, London, 1859. It was found to be too expensive for general use. An inflated air-bed is shown under Bed ; copied from a German work of A.D. 1511.

Air′-blast. See Blower.

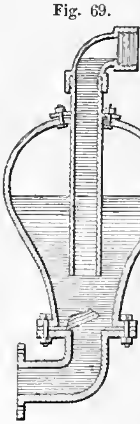
Air′-brick. An iron box made of the size of a brick, and having a grated side. It is built into a wall, and forms a ventilating opening.

Air, Car′bu-ret-ing. See Carbureting Gas and Air.

Air′-cas′ing. A sheet-iron casing around the funnel on board a steam-vessel, to prevent the transmission of heat to the deck.

Air′-cham′ber for Pumps. This was used by Dr. Papin of France about 1695, but had been described nearly two thousand years previously by Hero in his "Spiritalia." It was attached by Perrault, in 1684, to the fire-engine (*Pompe Portative*) of Duperrier.

Fig. 69.



Air-Chamber.

It is intended to equalize the flow of water from a reciprocating pump. The action of the pump being intermittent, the tendency is pulsative and the delivery in jerks. The body of air confined in the upper part of the chamber forms an elastic cushion against which the water impinges when lifted ; when the pump-piston stops to commence its return movement, the air again expands and continues the flow of water during the interval of inaction of the piston ; the valve falls as soon as water ceases to enter the chamber, to prevent return of the water by the induction-pipe, when the air expands.

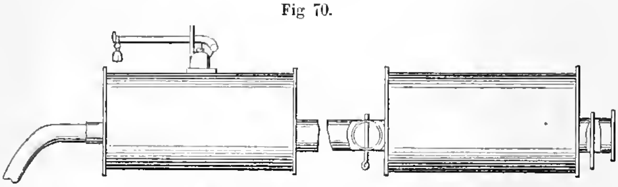
Air′-com-press′ing Ma-chine′. A machine adapted to condense air as a motor, or for ventilation in shafts and mines. For this purpose air is particularly well adapted, because its exhaust in the mine shaft or tunnel affords a direct means of ventilation by supply of vital air at the point where the work is under way. The works at the Mont Cenis and Hoosac Tunnels are notable instances of the use of compressed air carried to a great distance. The air-compressing engine of Sommeilleur at Bardonneche worked the rock-drills at the Italian end of the Mont Cenis Tunnel, and was operated by the displacement of air from a pipe by a heavy column of water obtained from the hills. See Compressed-air Machine ; Tunnel. The escape of steam at the point of work is not so desirable as that of air for two reasons : the condensation of the former prevents its acting to produce an outflow of air towards the mouth, as is produced by the escaping and expanding air ; and it only adds to the dampness and obscurity of the usually wet shaft or drift, instead of being a source of supply for breathing, from the healthy region of the exterior air.

Many of the devices for merely assisting ventilation are no more than blowers (which see), but for use as a motor a more positive condensation is required. By the law of Mariotte, the elastic force of air varies in the proportion of its density ; the greater the pressure the smaller the volume. Assuming the natural pressure to be 15 pounds to the square inch, by reducing the volume to one half we shall have a pressure of 30 pounds to the square inch; to one quarter, 60 pounds; to one tenth, 150 pounds; to one fortieth, 600 pounds.

The stroke of a piston in its cylinder, therefore, if it reduce a body of air to one twentieth its original volume, will subject it to a pressure of 300 pounds to the square inch. The air is generally allowed to escape by a valve-way before the approaching piston, and is collected in a reservoir, whence it passes to the machinery where its expansive force is to be applied. The circumstances of position and use are so very varied that no general statement of its mode of application will apply. Sometimes it is stored in reservoirs at the point where it is used as a motor or a ventilator.

Fisk and Waterman, January 17, 1865. The reservoirs for compressed air are located within the mine, and connected by comparatively large induction-pipes with the air-forcing pump at the mouth of the mine. The object is to exert a uniform pressure at the working point, where compressed air is used as a motor, and to prevent a stoppage of the ventilation during a temporary stoppage of the compressing-engine at the mouth of the mine. The

Fig 70.

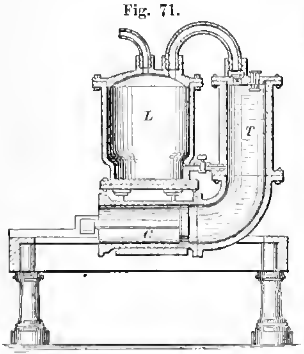


Fisk and Waterman's Compressed-Air Reservoir.

eduction-tubes by which the air is discharged from the reservoir are of comparatively small diameter, and are provided with stop-valves.

Holly, May 22, 1866. Water is urged by the piston C and forced through the curved pipe into the reservoir L. As the piston recedes, the valve in the head of the air-cylinder T is opened, to supply the cylinder with air. Water collecting in the reservoir is passed by a pipe to the cylinder T. Water between the piston and the air permits a water-tight instead of air-tight packing to be used, the air retreating before the column of water at each forward stroke of the piston and following it during its return stroke.

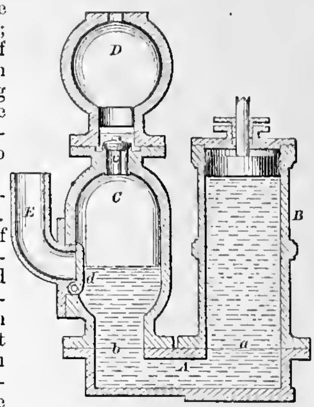
Fig. 71.



Holly's Air-Compressing Pump.

Ransom, August 8, 1865. The two cylinders are connected at bottom by a hollow bed-plate A, and have a constant amount of water, which is made the intermediate between the piston in the cylinder B and the air which occupies cylinder C. As the piston descends, the column of water rises in cylinder C and ejects the air, which passes through the valve-way c into the dome D, the pressure closing the valve d. As the piston is raised, the water retreats, the valve c closes, valve d opens and admits air by the duct E to the cylinder C. The motion is repeated; the intervention of the water, as in the last-preceding case, obviating the necessity for an air-tight packing to the piston.

Fig. 72.

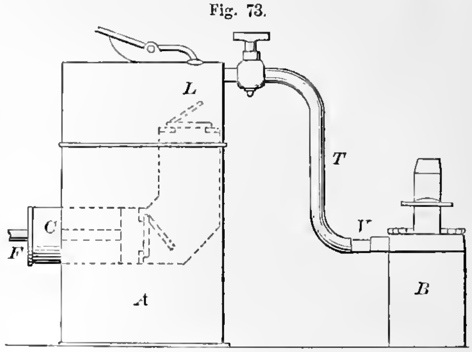


Ransom's Air-Compressing Pump.

Wilhelm, December 26, 1865. A pump C F, of ordinary construction, is enclosed within a large air-chamber L, which has no bottom, but is suspended in an open vessel of water A, so that the water may rise high in the chamber, and when driven back by the force of the air may continue a pressure thereon and thus keep up a continuous blast. This may be better adapted for a blower, but, by arranging for a high vertical column of water, it may be applied to more positive and high-pressure purposes.

Patric, April 18, 1865. This device is intended to be placed at the foot of a waterfall, the water acting in alternate compartments E, E, which are separated by a flexible diaphragm connected to an adjusting-bar b, that operates the inlet and outlet water-valves e a of each chamber. When either compartment is emptied of the water contained therein.

Fig. 73.



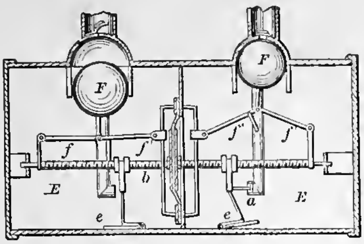
Wilhelm's Air-Pump.

an air-valve is opened and the air rushes in and fills the space vacated by the water, when, at the proper time, by the action of the floats F, and levers f f', acting upon the diaphragm, the inlet-valve is opened, the water enters by virtue of its gravity, and the air is compressed and forced out of that compartment to a suitable reservoir, where it is reserved for use in any suitable engine.

The efficient force depends upon the height of the column of water, and the consequent force with which the air was ejected by the water which displaced it.

Jameson, March 13, 1858. The air is compressed (or rarefied by the inversion of the process) by the successive action of pistons in cylinders connected

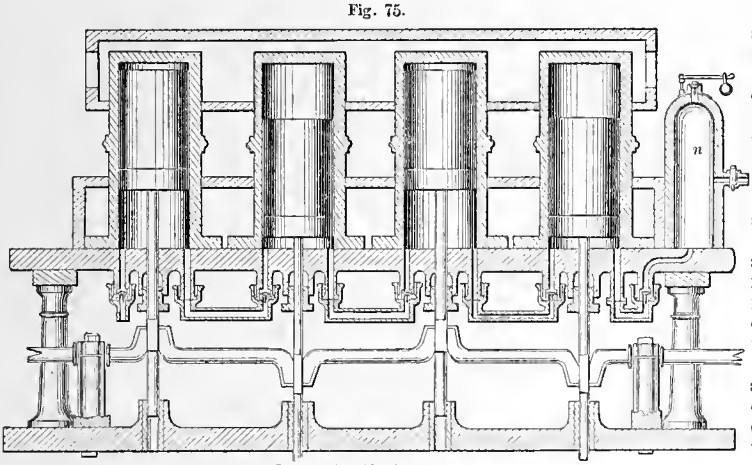
Fig. 74.



Patric's Air-Compressor.

by pipes, whose valves govern the direction of the flow. Each piston is connected to a crank on the common rotary-shaft beneath. As the air passes from one to the other, it receives an additional condensation, and is eventually stored in the reservoir n, at the end of the series ; from thence it is drawn, as required, to act as a motor, a blast, or for any other purpose for which it is adapted. The cylinders are enveloped by passages where a heater or refrigerant may be placed to act upon the air. Air develops sensible heat as its volume is diminished by compression, and if it be used for cooling purposes, as in ice-making, its preliminary cooling before it is allowed to expand will make it more effective in absorbing sensible heat when freed.

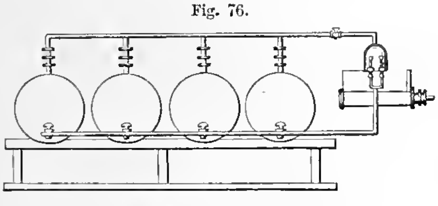
Fig. 75.



Jameson's Air-Compressor.

Arthur, July 25, 1865. An air-pump is combined with a series of air-vessels by means of pipes and stop-cocks, or valves, in such a manner that the air compressed into one air-vessel may be used to supply the pump when compressing air into one or more other air-vessels to a higher tension, the air entering the pump-barrel being thus already compressed to a certain tension. The amount of increase in tension which the pump is required to produce need not exceed that at which it will work advantageously. In the last reservoir in the series the air is further compressed by forcing water into the lower part thereof by means of another pump. The air is compressed more and more by the successive operations, a single pump being required. The pump is connected to such one of the reservoirs as may be required, and discharges into another or others, the power required to work the pump being only the difference between the pressure in the two.

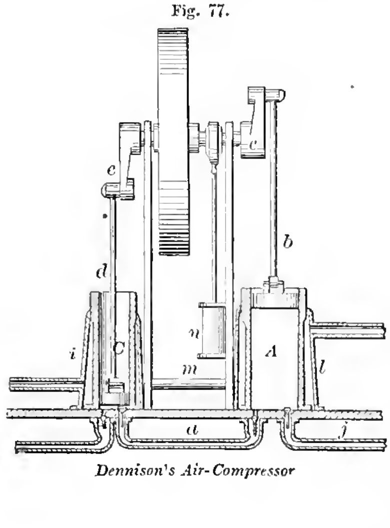
Fig. 76.



Arthur's Air-Compressor.

Dennison, October 23, 1866. The pistons are attached to cranks set at 180° on the same shaft, and reciprocate in cylinders of varying diameters, the larger having an air induction-pipe, and discharging into the smaller, which has an eduction-pipe. A water-jacket keeps the parts cool. By this means the air receives a double condensation ; the difference between the sectional areas of the cylinders is such that in each a similar amount of power is exerted. The induction and eduction pipes of the single-acting cylinders are provided with valves which govern the direction of the air, opening and closing automatically. The pipe B conducts water to the jackets around the cylinders, to remove the heat evolved by the compression of the volume of the air. The pipe C removes the water. The abstraction of heat, of course, lessens the pressure. This is desirable for some purposes, not for others. Hot water or steam, acting in the reverse direction to a refrigerant, would be adapted to increase the effect of the air as an expansive motor. Alternate expansion and contraction was the whole principle of the M. I. Brunel Gas-Engine Patent, England, 1804.

Fig. 77.



Dennison's Air-Compressor

Heated carbonic-acid gas is preferable to air for developing a large force in small space. See GAS-ENGINE. See also AIR-ENGINE; COMPRESSED-AIR ENGINE; AIR AS A WATER-ELEVATOR.

Air′-cone. In marine engines; to receive the gases which enter the hot-well from the air-pump, whence, after ascending, they escape through a pipe at the top.—ADMIRAL SMYTH.

Air′-cool′ing Ap pa-ra′tus. In this article will be considered the devices for cooling a current of air, for purposes of health and ventilation, and not those involved in producing anæsthesia by cold, the manufacture of ice, or the cooling of fruit and meat chambers. These will be considered under their appropriate heads. The purpose of the former two of these is to reduce the temperature below the freezing-point, and of the latter to reduce it nearly to that point, while for purposes of ventilation the aim is to reduce to a moderate degree the passing volume of air which escapes and gives place to that which is following.

The circulation is not a necessary incident to ice-making or to the fruit-house, though in the latter there is no doubt that circulation of air is a valuble feature in retaining the purity of the atmosphere in the chamber.

Another large class of inventions in which an artificial blast of cold air is employed is the beer and liquid coolers, which are of three kinds: those in which an artificial blast is driven through the arms of the stirrer to cool the contents of the mash-tub; those in which the liquid is passed through a refrigerating vessel and is cooled by contact therewith; those in which refrigerating effects are imparted to a vessel containing liquor on draft, to reduce its tendency to fermentation or to make it more palatable. See LIQUID-COOLER; ICE-MANUFACTURING; ANÆSTHETIC APPARATUS; FRUIT AND MEAT CHAMBER.

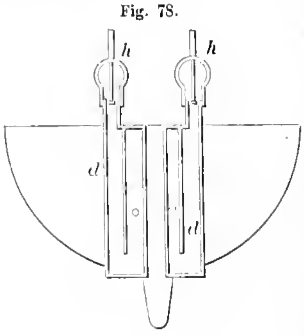
The East Indian Tatta is a screen of finely woven bamboo in a frame which fits into a window-opening. It is kept constantly moist by trickling water, and thus cools the air as it enters the apartment, while the screen also excludes insects.

The same effect is produced by an arrangement which keeps moist the mosquito-bar around the bed.

The Alcaraza is a Spanish form of the same device.

SOMES's plan for ventilating ships, February 28, 1865. The design of the apparatus is to expose a current of air to contact with vessels or pipes filled with water taken from a distance below the surface. The system of pipes is arranged at any convenient submerged point on the ship's sides, and the air is forced in contact therewith by the motion of the vessel, or the action of the waves. The cooled air is conducted by pipes to cool and ventilate the various apartments in the vessel, or the grain or other perishable freight with which it may be loaded.

Fig. 78.



Somes's Ship-Ventilator.

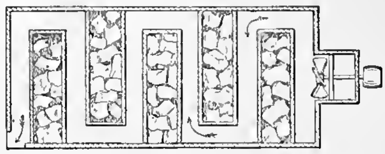
See also THIERS's AMERICAN PATENT, 1871. See SHIP-VENTILATING.

In SOMES's plan for ventilating, cooling, and heating the Capitol, the air is introduced into a vault so far beneath the surface as to be free from the changes of temperature incident to the seasons. The air is conducted by a conduit, in which it is exposed to pipes whose contents have a warming or refrigerating effect upon the passing air. Purifying and moistening influences are also brought to bear upon the air.

In his patent of October 15, 1867, vacuum and compressing chambers are used in combination with the pumps which create the current of air. Atomizing tubes are added to reduce the temperature and impart moisture, the disseminated liquid becoming vaporized and absorbing free caloric from the air. Another plan is to force a body of air through pipes which pass to the cold earth below the surface, or to expose air to the contact of pipes filled with water which has been conducted to the said depth. It is suggested, in connection with this, that the air may be condensed in the cooler and become further cooled as it expands.

SHALER's air-cooler, May 30, 1865. The case contains a series of cells so arranged as to form a

Fig 79.



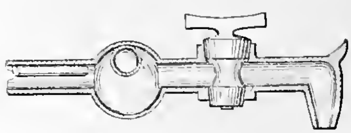
Shaler's Air-cooling Apparatus

tortuous passage. The chambers are filled with ice, and the air is caused to circulate through the passage by means of a fan.

In MAINE's apparatus for cooling and disinfecting air, December 4, 1866, a continuous apron of porous material is passed through the tank containing the disinfecting and cooling liquid, and thence passes over rollers rotated by clock-work, its surface being exposed to a current of air, generated by a fan which is driven by the same motor as the rollers. See AIR-FILTER.

Air′-cush′ion for Pipes. The object is to avoid the jar which occurs when a column of water in motion is suddenly arrested. Various means have been tried, prominent among which are air-chambers. Air, however, is gradually absorbed by the water, and as a means of imprisoning it and still allowing it to contract when the jar comes, and afterwards to expand, it is enclosed in a ball of india-rubber. This is shown in BEVAN's patent, March 14, 1865, and in some others. The arrangement also allows the expansion of the water, in freezing, without bursting the pipe. The sack is placed in an enlargement of the pipe, and so caged as not to stop the flow. A continuous tube of the same material, and containing air, is arranged in the tube also.

Fig 80.



Bevan's Air-Cushion for Pipes.

Air′-drain. (*Building.*) A cavity around the subterranean walls of a building, protected by a wall on the earth side, and designed to prevent the absorption of moisture by the wall.

Air′-drill. A drill driven by the elastic pressure of condensed air. The construction usually resembles the reciprocating steam-engine, compressed air being substituted for the steam; the drill-stock is attached to the piston-rod. It is usually termed the PNEUMATIC DRILL, which see.

Air'-en'-gine. For more than a century the attention of mechanicians has been directed to means for making air and gases available in driving machinery. The inventions resulting from these efforts have led in different directions, or to different sets of specific means.

AMOUTON (France, 1699) had an atmospheric fire-wheel, or air-engine, in which a heated column of air was made to drive a wheel. A smoke-jack is a familiar instance of the same on a small scale. So are the toys now attached to stove-pipes and representing incipient men (monkeys) sawing wood, etc.

Some have attempted to make available the expansion of air, previously mechanically condensed and stored in reservoirs. It was not understood, apparently, that the valuable effect would only be equal to the force employed in condensing the air, minus some friction, leakage, and other incidentals. This form settled down into two classes of machines: 1. Those which were locomotive in their character, as in BOMPAS's air-driven carriage (English patent, 1828), where air was condensed in tanks and admitted to the alternate ends of a cylinder, which had a reciprocating piston, connected in the usual manner to the crank and drive-shaft. The same device, substantially, was used by Von Rathen in 1848, at Putney, England, where he ran an air-locomotive at the rate of ten or twelve miles an hour. See COMPRESSED-AIR ENGINE. 2. Those in which a body of air is condensed into a reservoir, placed at the bottom of a shaft, or in a situation where the prime motor cannot be set up. In this case the engine in the mine is run by the air from the reservoir during a lull in the force of the prime motor. This was the subject of a patent in England, to MEDHURST, 1799. He condensed air to one fifteenth of its volume, and stored it for this purpose. The air-reservoirs of FISK (U. S. patent, 1865) have a similar purpose. See AIR-COMPRESSING MACHINE.

Another form of air-engine has consisted of two chambers filled with air or gas, and connecting by pipes with the respective ends of a cylinder in which a piston reciprocates as the bodies of air in the said cylinders are alternately expanded and contracted. STIRLING's engine (English patent, 1827) was of this character, and is stated by Chambers to have been unsuccessful, owing to mechanical defects and to "the unforeseen accumulation of heat, — not fully extracted by the sieves or small passages in the cool part of the regenerator, of which the external surface was not sufficiently large to throw off the unrecovered heat when the engine was working with highly compressed air." Mr. Stirling was stated, by the same authority, to have been the originator (1816) of the regenerator wherein the heat of the exhausting air is made to heat surfaces which communicate heat to the incoming air for the next charge. The distinctive form of apparatus was no doubt new with Mr. Stirling, but the main idea is much older, as it is found in the English patent of Glazebrook, 1797. Stirling's regenerator is described as "consisting of a chamber or chambers filled with metallic sieves of wire-gauze, or minutely divided metallic passages, through which the air is made to pass *outward* from the cylinder, after having performed its work on the working-piston of the engine, leaving a great part of its heat in the sieves or narrow passages, to be given out by them again to the returning air, which is made to pass *inward* through the same sieves or narrow passages, and by a slight accession of new heat from the furnace, to produce another effective stroke of the piston. By repeating this process at each stroke of the engine, it is evident that a large portion of the heat that would otherwise go to waste will be used many times over, and thus a smaller amount of new heat will require to be supplied from the heating furnace of the engine, and a corresponding saving of fuel be effected."

Such is the description, but the statement is open to objections.

A further improvement of Messrs. Stirling was patented in England, in 1840.

In this engine two strong air-tight vessels are connected with the opposite ends of a cylinder, in which a piston works in the usual manner. About four fifths of the interior space in these vessels is occupied by two similar air-vessels, or plungers, suspended to the opposite extremities of a beam, and capable of being alternately moved up and down to the extent of the remaining fifth. By the motion of these interior vessels the air to be operated upon is moved from one end of the exterior vessel to the other; and as one end is kept at a high temperature, and the other as cold as possible, when the air is brought to the hot end it becomes heated, and has its pressure increased, whereas its heat and pressure are diminished when it is forced to the cold end. Now, as the interior vessels necessarily move in opposite directions, it follows that the pressure of the enclosed air in the one vessel is increased, while that of the other is diminished; a difference of pressure is produced on opposite sides of the piston, which is made to move from one end of the cylinder to the other. The piston is connected with a fly-wheel, and motion communicated in the usual way.

In this engine the air received heat at the temperature of 650° Fah., and discharged the lost heat at that of 150° Fah. The efficiency of a theoretically perfect engine with those limits of temperature would be 0.45, and its consumption of coal 0.73 of a lb. per horse-power per hour. The actual consumption of coal per horse-power per hour was about 2.2 lbs., being three times the consumption of a theoretically perfect engine, and corresponding to an actual efficiency of 0.15, or one third of the maximum theoretical efficiency. Stirling's air-engine was therefore more economical than any existing double-action steam-engine. The following is a comparison of the consumption of bituminous coal of specified quality per horse-power per hour: —

	lbs.
1. For a theoretically perfect engine, working between such limits of temperature as is usual in a steam-engine . . .	1.86
2. For a double-acting steam-engine, impelled to the utmost probable extent . .	2.50
3. For a well-constructed and properly worked ordinary steam-engine, on an average	4.00

One engine constructed in this manner had a cylinder 12 inches in diameter, 2 feet stroke, and is stated to have worked to 20 horse-power; another engine with a cylinder 16 inches in diameter, 4 feet stroke, worked up to 40 horse-power. The latter, we are informed, did all the work of the Dundee Foundry Company for three years; using only one fourth the amount of fuel previously consumed by its predecessor, the steam-engine. It was then laid aside, owing to some difficulty in renewing the heater. Perhaps it incurred a heavy expense in wear, tear, and the burning out of parts.

The construction of the engine seems to have been essentially a duplication of the invention of PARKINSON AND CROSLEY, English patent, 1827.

In this engine the air-chamber is partly exposed, by submergence in cold water, to external cold, and its upper portion is heated by steam. An internal vessel moves up and down in this chamber, and in so doing displaces the air, alternately exposing it to the hot and cold influences of the cold water and the hot steam, changing its temperature and expansive condition. The fluctuations cause the reciprocation of a piston in a cylinder to whose ends the air-chamber is alternately connected.

While treating of that form of air-engine which depends upon the variation in the thermometric condition of a body or bodies of air, which connect with the opposite sides of the piston alternately, it may be well to mention the engine of BRUNEL, in which carbonic acid gas is stored in two chambers, communicating with the respective ends of the cylinder and operating the piston therein by their thermometric fluctuations. See GAS-ENGINE.

A third form of the apparatus embraces but few features, but these have been modified according to the convictions of independent inventors to such an extent that they are represented by eighty patents now before the writer.

These features may be described as found in GLAZEBROOK's English patent, 1797; a condensed statement of which is as follows: 1. A force-pump to compress the cool air; 2. a chamber in which the fluid is saturated with moisture (this is not retained by all the modern forms, but is by some); 3. A heater where its expansive force is increased; 4. A cylinder in which its expansive force is utilized against a piston; 5. A mode of utilizing the heat of the outgoing air, to heat the new charge of compressed cool air for another stroke. Of this latter feature, more hereafter.

In Glazebrook's, the piston of the working-cylinder and that of the pump-cylinder connect with the opposite ends of the working-beam. This inventor's statements of the principles of the operation of his machine are worthy of being quoted at length, but must be condensed for our purpose and limits. His engine was of the differential order, and he states the measure of power to be the difference of force exerted in the working and air-compressing cylinders, of which the latter is much the smaller, and the extra force in the former is due to the accession of heat derived from the furnace wherein the air is heated after compression in the smaller cylinder, and before it is admitted to and allowed to expand against the piston in the larger cylinder. Viewing the history of the air-engine for the seventy years succeeding Glazebrook, we may at least say that he is a great anticipator.

Glazebrook's second patent, 1801, has a refrigeratory, whose use is not, as in RANDOLPH's (Scotland, 1856), to cool the pump wherein the air is condensed (see COMPRESSED-AIR ENGINE), but is used for depriving the escaping gas of its heat, in case a gas be used of so expensive a character as to preclude its being ejected into the atmosphere after using. This is probably the commencement of using the same air over and over again. He cites carbonic acid and other gases and compounds. He only antedated by three years the engine of Brunel, which was intended to be used without any escape of carbonic acid; two volumes of which were made to fluctuate in temperature alternately, and produce a pulsation in the chamber placed between them, and in which the piston worked.

LILLEY's air-engine, English patent, 1819, may be simply noticed as in the same line of invention. The air is compressed by mechanical force; passed through heated tubes, expanded against a piston, and then escapes into the open air.

The first working-cylinders of the ERICSSON were 168 inches in diameter, and the piston had a stroke of 8 feet, the air being introduced at natural pressure into the heater. The inadequacy of the power developed, and difficulties incident to the scale of the machinery induced him to make it more compact by condensing the air mechanically, and reducing the size of the working-cylinders to 72 inches diameter, and 6 feet stroke. This condensation he did not claim as his own invention, as we understand; but it is claimed for Stirling at the date of his second patent, 1827. This, however, is not correct, for it is found in the specification of Lilley, English patent, 1819, and in Glazebrook's, 1797. This patent of Glazebrook, in connection with his improvement of 1801, may be considered the most remarkable one of the series, and has just been mentioned. The action of Ericsson gave a great impetus to the invention and building of air-engines; examples will be cited presently. Air-engines on a small scale are extensively used in driving printing-presses and such like work. It is believed that they are especially suitable for positions where water is scarce, and suggestions have been made for their use in prairie farming, without anything definite being reached in that direction.

The claims put forward for the Ericsson engine indicate that he expected to use the same portion of heat in producing mechanical power over and over again. One who advocated the cause stated that "the basis of the caloric engine is that of returning the heat at each stroke of the piston, and using it over and over again." "This result," he remarks, "Captain Ericsson has attained by means of an apparatus which he styles a regenerator, and so perfectly does it operate that the heat employed in first setting the engine in motion continues to sustain it in full working-force, with no other renewal or addition than may be requisite to supply the inconsiderable loss by radiation."

This would be the legitimate conclusion of the premises stated, and the *reductio ad absurdum*, one would have thought, would have opened the eyes of the claimant. If the statement were true, the engine would become hotter and hotter, unless the fire was almost put out when the engine commenced running, and the power would be used over again to an extent which would put to the blush the mechanical equivalent of a unit of heat in a theoretically perfect engine; a consummation unexpected, to say the least.

The effect of the claim is, that the heat of the outgoing air is perfectly withdrawn by the regenerator and transferred to the charge of incoming air on its way to the engine, and this without the expenditure of power. The fallacy of the statement, for which Mr. Ericsson may not be responsible, is in supposing that the air could be passed into and through the regenerator in the manner proposed, without the exertion of power. The air, as it enters the regenerator, would expand with the increment of heat acquired therein, and a given volume would require the expenditure of a force to drive or draw it through equal to that which the heat thus absorbed, and expansive condition acquired, would be capable of exerting.

If no power were exerted to induct the air, under these circumstances of expansion, only a part of the charge required would pass into the chamber, and that which reached the furnace would be already attenuated by expansion. Expansion presupposes the expenditure of power, and is produced by heat in this case; the relation of heat to power, and conversely, must not be ignored. The interposition of the air-pump does not affect the problem, for the attenuation of the air by heat will necessitate a greater power to condense a body of air, of given normal volume, into the space where its expansive powers are to be exerted

The regenerator was used by Stirling, 1816, and Glazebrook, 1797, in air-engines. The forms of the regenerators, however, differ considerably. Stirling's is described in this article, and Glazebrook's appears to have been like a modern air-heater in which the hot current heated pipes filled with the incoming air.

Mr. Ewbank, speaking of the Ericsson regenerator, says: "The principle on which this invention rests is the repeated use of the same caloric. In this engine, as in the steam-engine, heat is the animating principle; and in using over and over again the same heat, he virtually uses over and over again the same power. He claims to have succeeded in saving upwards of 90 per cent of the heat expended in raising a loaded piston, and in retaining and compelling it to do the same work over again." PAINE in his United States patent, November 30, 1858, moistens and refrigerates the incoming air so as to reduce its bulk, for the sake of getting a partially condensed volume for the supply of the air-pump.

A writer in the English Encyclopædia states the Ericsson experiments as follows: —

"In the summer of 1852 two of Ericsson's caloric engines were at work in a factory at New York; and as newspaper paragraphs frequently appeared, presenting most favorable accounts of the working of these engines, arrangements were planned for building a ship of 1000 tons' burden, to be propelled by hot air instead of steam. It was anticipated that the Atlantic might be crossed by such a ship in fifteen days, at a vastly cheaper rate than by the superb but costly Cunard steamers, thereby more than compensating for the quicker passage of the latter. The ship was 250 feet long, and had paddle-wheels 32 feet in diameter. On its first trial-trip, January 4, 1853, the ship made twelve knots an hour with the wind, and answered her helm well; she only used six tons of fuel per day, and was pronounced a success by her friends.

"On the second trial, the maximum speed attained was nine knots, — obtained, as asserted, at a cost only one sixth of that of steam. After this, unfavorable circumstances, one by one, came to light; and the ship named the 'Ericsson,' in honor of the inventor, failed to establish the validity of the principle involved. Influenced by the results of further experiments made in 1854, the indefatigable inventor took out another patent in 1855 for certain novelties in the apparatus. In this new caloric engine, the heated air, after performing its duty by raising the piston in the working-cylinder, is made to circulate through a vessel containing a series of tubes: and the current of heated air, in passsing through this vessel or regenerator, is met by a current of cold air, circulating in an opposite direction through the series of tubes on its way to the working-cylinder.

"Thus there is cold air within the tubes and hot air without, an interchange takes place, or rather an equalization, by a transference of caloric from one to the other.

"The current of cold air, on its way to the working-cylinder, after thus having been partially heated by the transference of caloric, is made to pass through a series of tubes or vessels exposed to the fire of a furnace.

"The action of the engine itself is what is called 'differential,' the motive energy depending on the difference of areas in the working and supply cylinders. [And the superior energy of the charge in the former due to its increment of heat derived from the furnace. — ED.]

"The heater and regenerator are supplied with fresh compressed atmospheric air at each stroke of the engine.

"In the year now under notice [1855], the old caloric engine was taken out of the 'Ericsson,' and steam-engines substituted. Captain Ericsson would not admit, however, that this was an evidence of failure in his plans; he still asserted the soundness of the principle, and the economy in fuel.

"The first engine made was, he said, too cumbrous for the available amount of power in the ship, and the losses by leakage and friction were greater than had been anticipated. A second was made; but the joints of the pipes of the heaters were not good, and could not bear a greater pressure than such as would produce a speed of seven knots an hour. Surcharged or overheated steam was used, because the hot air escaped, and then occurred a dislocation of the whole machinery by an explosion.

"This action led to the substitution of steam-boilers; but even then Ericsson would not admit that the *principle* of his caloric engine was proved to be unsound; seeing that the accident had arisen from mechanical defects, and that the change consisted only in the use of steam-boilers instead of air-heaters." The English writer is here incorrect, as she was supplied with steam-boilers *and* engines.

The "Ericsson" made a trip from New York to Washington, and is said to have used an enormous quantity of tallow in lubricating her machinery. This difficulty is avoided in some of the smaller machines now built, by saturating the air with steam. See AËRO-STEAM ENGINE.

In a paper read by Mr. Rankine before the British Association in Liverpool, September, 1854, is a succinct statement of the principles underlying this subject of invention; from it we derive the following: —

"Heat acts as a source of mechanical power by expanding bodies, and conversely, when mechanical power is expended in compressing bodies, or in producing friction, heat is evolved. This mutual convertibility of heat and mechanical power is expressed in the following law: 'That when mechanical power is produced by the expenditure of heat, a quantity of heat disappears, bearing a fixed proportion to the power produced; and conversely, that when heat is produced by the expenditure of mechanical power, the quantity of heat produced bears a fixed proportion to the power expended. This law has been established chiefly by the experiments of Mr. Joule on the production of heat by the friction of the particles of various substances, solid, liquid, and gaseous, and he has ascertained the fixed proportion which heat and mechanical power bear to each other in cases of mutual conversion.

"The *unit of heat* — or so much heat as is sufficient to raise the temperature of one pound of water at ordinary temperatures by one degree of Fahrenheit's thermometer — requires for its production, and produces by its disappearance, or, in other words, is equivalent to, 772 lbs. of mechanical power; that is, so much mechanical power as is sufficient to lift a weight of 1 lb. to a height of 772 feet. This quantity is known as *Joule's equivalent*, or the dynamical specific heat of water at ordinary temperatures. The dynamical specific heats of other substances may be determined by direct experiment, or by ascertaining the ratios to that of water. Thus, to heat 1 lb. of atmospheric air, maintained at a constant volume, by 1° Fahrenheit, requires the expenditure of 130.5 foot lbs. of mechanical power. This is the *real* dynamical specific heat of air. The *apparent* dynamical specific heat of 1 lb. of air, under constant pressure, is, for 1° Fah., 183.7 foot lbs.; the difference, or 53.2 foot lbs., being the mechanical power exerted by the air in expanding, so as to preserve the same pressure notwithstanding the increase of its temperature by 1°. The apparent specific heat of air at constant pressure exceeds the real specific heat in the ratio of 1.41 : 1. All quantities of heat may thus be expressed by equivalent quantities of mechanical power. The heat required to raise 1 lb. of water from the freezing to the boiling point, and to evaporate it at the latter temperature, is 1,147.5° × 772 = 885,870 foot lbs.: of which 180° × 772 = 138,960 foot lbs. is sensible heat, or that employed in raising the temperature of the water; while the remainder, 967.5 × 772 = 746,910 foot lbs., is the latent heat of evaporation of 1 lb. water at 212° Fah., or the heat that disappears in overcoming the mutual attraction of the particles of water, and the external pressure under which it evaporates. The mechanical equivalent of the available heat produced by 1 lb. of ordinary steam coal may be taken on an average of that of the heat required to raise 7 lbs. of water from 50° to 212° Fah., and to evaporate it at the latter temperature, that is to say, in round numbers, 6,000,000 foot lbs. The total heat is much greater, but there is a loss in the gases which ascend the chimney.

"Heat, being convertible with mechanical power, is convertible also with the *vis viva* of a body in motion. The British unit of heat, 1° Fah. in 1 lb. of water, is equivalent to the *vis viva* of a mass weighing 1 lb. moving with a velocity of 223 feet per second, being the velocity acquired in falling through a height of 772 feet. A mass of water, of which each particle is in motion with this velocity, has its temperature elevated by 1° of Fah. upon the extinction of the motion, by the mutual friction of the particles. Heat communicated to a substance produces in general three kinds of effects (omitting the chemical and electrical phenomena): 1. An increase of temperature and expansive pressure. 2. A change of volume, nearly always an increase. 3. A molecular change, as from the solid to the liquid, or from the liquid or solid to the gaseous state. The heat which produces the first kind of effects is known as *sensible* heat, and makes the body hotter. In the second and third kinds of effects heat disappears and becomes *latent*: but may be reproduced by reversing the change which caused it to disappear. In evaporating 1 lb. of water at 212° a quantity of heat disappears equivalent to 746,910 foot lbs. The pressure of the steam produced is 2,116.4 lbs. on the square foot. The volume is probably about 26½ cubic feet more than that of the liquid water. Multiplying these two quantities together, it appears that the heat expended in overcoming external pressure is equivalent to only 56,085 foot lbs., leaving 690,825 foot lbs. for the mechanical equivalent of the heat which disappears in overcoming the mutual attraction of the particles of the water. Whereas the latent heat of expansion of a permanent gas consists almost entirely of heat which disappears in overcoming the external pressure. Thus the product of the volume in cubic feet of 1 lb. of air, at 650° Fah., by its pressure in lbs. per square foot, is 59,074 foot lbs. If that 1 lb. of air be expanded under pressure to 1½ times its original volume, and still be maintained at the constant temperature of 650° by being supplied with heat from an external source, the work performed by it in expanding will be 59,074 × hyperbolic logarithm of 1½ = 23,953 foot lbs., and this quantity will also be sensibly equal to the mechanical equivalent to the heat supplied, and which disappears during the expansion. It is this heat which disappears in producing increase of volume under pressure, which is the real source of power in the performance of a thermo-dynamic engine; as it is a portion of this heat which is actually converted into mechanical work, while the heat expended in producing elevation of temperature produces merely a tendency to the development of power. When an elastic substance has to perform mechanical work through the agency of heat, it goes through a cycle of four processes, which, taken together, constitute a single stroke of the engine.

"*Process A.*—The substance is raised to an elevated temperature. This process may or may not involve an alteration of volume.

"*Process B.*—The substance, being maintained at the elevated temperature, increases in volume and propels a piston. During this process heat disappears, but an equivalent quantity is supplied from without, so that the temperature does not fall.

"*Process C.*—The substance is cooled down to its original low temperature, with or without a change of volume.

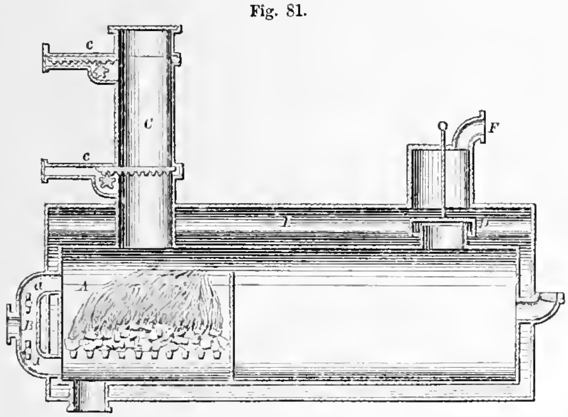
"*Process D.*—The substance, being maintained at its depressed temperature, is compressed, by the return of the piston, to its original volume. During this process heat is produced; and in order that it may not elevate the temperature of the substance, and give rise to an increased pressure, impeding the return of the piston, it must be abstracted as quickly as produced, by some external means of refrigeration. The substance, being now brought back to its original volume and temperature, is ready to undergo the cycle of processes again; or it may be rejected, and a fresh portion of the substance employed for the next stroke. In the latter case the operation of expelling the substance may take the place of process *D*. In some cases the processes *B*, *C*, or *D* may be first in the order of time. During the cycle of processes the working substance alternately increases and diminishes in volume in contact with a moving piston. During the increase of volume the pressure of the substance against the piston expends mechanical power in compressing the working substance. The increase of volume takes place at a higher temperature, and therefore at a higher pressure, than the diminution of volume; consequently, the mechanical power communicated to the piston exceeds that taken away from it. The surplus is the power of the engine, available for performing mechanical work. The efficiency of the thermo-dynamic engine is the ratio which the available power bears to the mechanical equivalent of the whole heat expended. If the heat communicated to the working substance entirely disappeared, the power produced by that engine would be the exact equivalent of the heat expended, or 772 foot lbs for each unit of heat, and its efficiency would be represented by unity. A perfect engine would produce power to the amount of 6,000,000 foot lbs., for each pound of coal consumed; and as a horse-power is 1,980,000 foot lbs. per hour, the consumption of coal would be 0.33 lb. per horse-power per hour. But of course there is a waste of heat and power to be allowed for in every engine before we can arrive at its actual efficiency."

The efficiency of a theoretically perfect engine, working between the same temperatures as Ericsson's, would be 0.404, corresponding to a consumption of 0.82 lb. of coal per horse-power per hour. The actual consumption was 1.87 lbs. of anthracite, or 2.8 lbs. of bituminous coal. This is about 3.4 times the consumption of a theoretically perfect engine, and corresponds to an actual efficiency of 0.118, being less than the maximum theoretical efficiency in the ratio 0.295 to 1. The waste of heat and power, therefore, in Ericsson's engine must have been very great, though it was economical of fuel as compared with steam-engines.

Many of the modern forms of air-engines conduct the incoming charge of air to the furnace and make it the means of maintaining combustion. The volatile results, abounding in carbon and deprived more or less perfectly of the oxygen, require washing to remove the dust and soot which would otherwise pass to the cylinder. Combustion is thus maintained under pressure, a condition considered by many to be very favorable to the economical use of the fuel.

Some of the air-engines of late construction use a larger or smaller proportion of steam, partly as a motor and partly as a lubricator of the

Fig. 81.



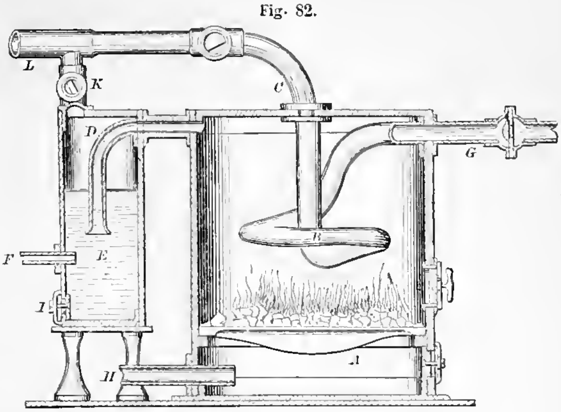
Bennett's Air-Heater and Steam-Generator.

parts which are apt to grind, working in the hot, dry air. See AËRO-STEAM ENGINE.

BENNETT, August 3, 1838. This is a combined air-heater and steam-generator, the combustion being maintained under pressure. The air is forced in by a pump, and enters above and below the grates in quantities regulated by the dampers *a*, *a*, in the branches of the pipe *B*. Coal is introduced through the charger *C* above, without allowing any notable amount of air to escape. The upper valve *c* being withdrawn, a charge of coal is dropped on to the lower valve, when the upper valve is shut, and the withdrawal of the lower one allows the coal to fall into the furnace *A*. The volatile products of combustion pass through the water-trap *D*, and mingle with the steam generated in the jacket *E*. The caloric current is purged of its grit and soot by the water in the trap *D*, and the combined heated air, gases, and steam pass by the pipe *F* to the engine. An equal pressure is maintained in the furnace and in the steam-generating chamber.

WASHBURN, September 5, 1865. The water passes by pipe *G* to the coil *B*, where it is converted into steam which passes off by pipe *C*. Air from a force-pump enters the ash-pit *A* by the pipe *H*, and after supporting combustion in the furnace, the volatile portions pass off by the pipe *D* to the wash-box *E*,

Fig. 82.

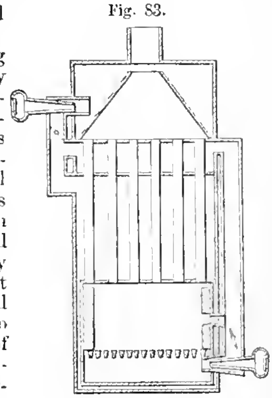


Washburn's Air-Heater and Steam-Generator.

where the grit and soot are arrested. *F* is a water-supply pipe and *I* a hand-hole for withdrawing accumulated matter arrested in the bath. After being deprived of impurities, the air passes by the pipe *K*, and joins the steam, the two passing by pipe *L* to the engine. The pressure throughout the apparatus is equal, the air and water being forced into it at a pressure equal to that of the outgoing steam and air. The steam-generating tube *B*, being exposed to equal pressure within and without, may be of light material, and the hot-air current may vaporize a portion of the water in the cleanser *E*, which is also supplied under pressure. The strength is in the outer walls.

STILLMAN, August 9, 1864. The air-heating chamber is surrounded by a steam-generator, the steam from which is made the means, by injectors, of introducing the supply of air below the grate of the furnace, and also at a higher point, where it acts to assist the draft. For this purpose the steam in the generator is maintained at a higher temperature than the air in the furnace, and acts as a substitute for the air-pump in affording a supply of air for combustion of the fuel under pressure.

Fig. 83.



Stillman's Hot-Air and Steam-Generator.

After the foregoing treatise on the early history of the air-engine and the consideration of the principles involved, the remainder of this article will be devoted to examples of the air-engines which have been introduced during the last twenty years. They are about eighty in number, and may be divided into five classes, in all of which the air is expanded by heat. (Air-engines into whose action heat does no enter as an effective agent are considered under COMPRESSED-AIR ENGINE, which see.)

1st. Those in which the air is compressed into a reservoir, emitted in graduated amounts, heated, used effectively against a piston in a cylinder, and then discharged. This is the most numerous class. Some of them pass their air-supply through the furnace, and in others it is only heated by the furnace. In the former the discharge of the air is a necessity, not so in the latter; this brings us to the

2d. Those in which the air or gas is not expended, but the same air is caused to return to the heater and be again expanded and utilized. This is the subject of the English patent of Glazebrook, 1801, and Laubereau, 1859; and the United States patent of the latter dated 1849.

3d. Those engines in which the air or gas is not expended, but occupies two reservoirs communicating with the cylinder on the respective sides of the piston; the air in said reservoir being alternately heated and cooled to change its expansive force and thus reciprocate the piston. This was the form of Brunel's engine, British, 1804; and Stirling's, British, 1827; and Peters's, 1862.

4th. Those engines in which water or steam is mingled with the air to moisten it and keep the working parts from abrasion; in some cases being introduced in quantity to be positively co-operative. These are AËRO-STEAM ENGINES, which see.

5th. Those engines in which the power derived is transferred to a body of water, to prevent burning the working parts and to obviate the necessity for air-tight joints.

It will be apparent that only a few representative examples can be shown within the limits assignable to this subject, in which, as is commonly the case, some inventors have numerous patents embracing details of construction, as the working of their engines developed defects and elicited remedies.

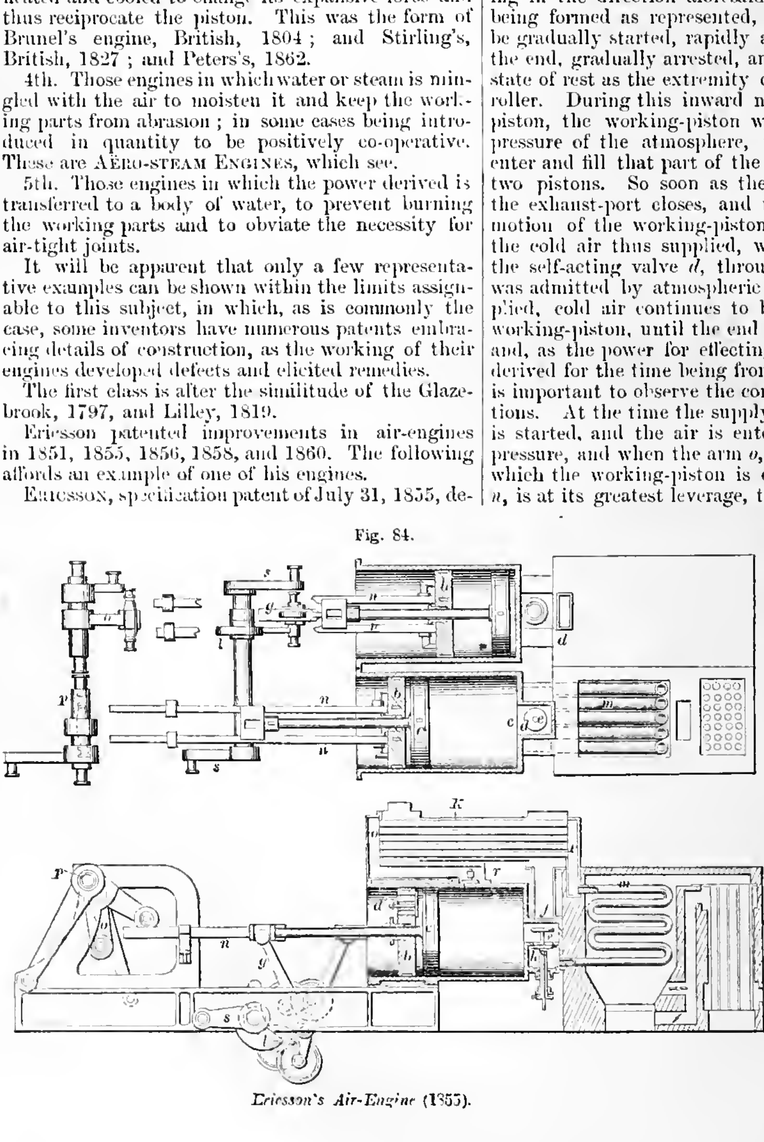
The first class is after the similitude of the Glazebrook, 1797, and Lilley, 1819.

Ericsson patented improvements in air-engines in 1851, 1855, 1856, 1858, and 1860. The following affords an example of one of his engines.

ERICSSON, specification patent of July 31, 1855, describes the invention substantially as follows (the illustration is reduced, from the official drawing, for this work): —

b is the working-piston; *c*, the supply-piston; *f*, the exhaust-port; *e*, the induction-port. The regenerator consists of tubes *k*; *m* are the heater-tubes. By means of a hand air-pump, applied to some part of the regenerator, a supply of atmospheric air is introduced at about the pressure of the atmosphere, and then the engine is in a condition to begin its operation. Starting with the pistons of one engine in the position represented in the lower view, Fig. 84, at the extremity of their outward stroke, as the crank *s*, moving in an upward direction is making that part of its circuit near the outer dead-point, and therefore imparting but little motion to the working-piston *b*, the supply-piston *c* is carried from the working-piston and towards the head of the cylinder with a rapid motion by the action of the cam on the roller of the arm *g*, the cam rotating in the direction aforesaid, and its acting face being formed as represented, that the piston may be gradually started, rapidly accelerated, and, near the end, gradually arrested, and there retained in a state of rest as the extremity of the cam passes the roller. During this inward motion of the supply-piston, the working-piston will be opened by the pressure of the atmosphere, to permit cold air to enter and fill that part of the cylinder between the two pistons. So soon as the supply-piston stops, the exhaust-port closes, and the continued inward motion of the working-piston begins to compress the cold air thus supplied, which of course closes the self-acting valve *d*, through which the supply was admitted by atmospheric pressure. Thus supplied, cold air continues to be compressed by the working-piston, until the end of its inward stroke; and, as the power for effecting this compression is derived for the time being from the other engine, it is important to observe the condition of the connections. At the time the supply-piston of one engine is started, and the air is entering by atmospheric pressure, and when the arm *o*, on rock-shaft *p*, with which the working-piston is connected by the rod *n*, is at its greatest leverage, the corresponding arm of the rock-shaft of the opposite engine is at its shortest leverage, but is moved inwards, and the supply-air, by reason of being gradually compressed, increases the resistance, the arm *o* gradually shortens in leverage, and the same arm of the opposite engine gradually, and in nearly the same ratio, increases in leverage, on the principle of the bent lever; thus applying the power required to compress the supply-air to the best advantage. It should be borne in mind, however, that the power thus applied to compress the supply-air is not actually expended, but merely borrowed; for it is so

Fig. 84.



Ericsson's Air-Engine (1855).

much added to the elastic force of the air by which, when heated, the engine is impelled.

Just before the supply-piston begins the inward stroke, just described, the eduction-valve *g* is opened, the induction-valve *h* having been previously closed so that the charge of the heated air, by which the previous stroke of the engine was effected, is permitted to escape freely into the atmosphere, so that the power required to move the supply-piston inward is very slight, the air escaping freely to the atmosphere on one side, and entering by atmospheric pressure on the other, through the valve *d*; but as the heated air exhausts or escapes from the cylinder, it passes around and among the series of small tubes *k*, of the regenerator, thus imparting its heat through the metal of the tubes to the cold air contained inside of the tubes, which air is thus partially heated preparatory to being finally heated in passing through the heater-tubes. In this way much of the heat which would be otherwise wasted is saved. The supply of cold air having been introduced and compressed, the engine is prepared to be impelled by the expansive force of the heated air. The eduction-valve *g*, having been closed during the greater part of the inward motion of the working-piston, the induction-valve *h* is now opened, which admits the heated air from the heater of the cylinder by which the supply-piston is forced outwards towards the working-piston. The form of the fall of the cam *l* is such as to cause the piston to be carried back with a rapid accelerated motion, until it comes nearly in contact with the working-piston; and, at first, in this outward motion of the supply-piston, the already compressed supply-air between the two pistons is still further compressed, not by the power of the engine, but by the elastic force of the heated air, the supply-piston being as it were suspended between the heated air from the heater on one side and the cold air of the other, with the self-acting valve *r* (in the side of the cylinder) interposed between the two; for it must be remembered that, as the heater and regenerator are in communication, the air, which is a perfectly elastic fluid, will be under equal pressure in both, notwithstanding a portion is more highly heated than the other; and, as the supply-air in the cylinder is simply separated from the air in the regenerator by the interposed valve *r*, in the side of the cylinder, the supply-piston will be moved outwards by the heated air, until the supply-air is compressed to an equal tension, and then the further motion of the supply-piston, effected by the cam *l*, as it approaches the working-piston, will transfer the supply-air from the cylinder to the regenerator, through valve *r*. The only power expended by the engine in this transfer will be the small amount required to move the supply-piston, between two equal pressures, to give the slight preponderance to the one necessary to open the valve *r*, through which the transfer is made. The moment the supply-piston passes this valve and overtakes the working-piston, the preponderance of pressure ceases, and the valve closes by gravity.

The specification states: "I *claim* the method of supplying fresh air to the engine, compressing and transferring it to the regenerator and heater, or either, by the action of the supply and working pistons within the one cylinder, operating on the principle and in the manner substantially as described, whereby the air is admitted, under atmospheric pressure, as the supply-piston is moving from the working-piston, as the previous charge of heated air is exhausting; so that the said supply-piston moves in equilibrio, or nearly so, and by which also the supply-air is finally compressed and then transferred to the regenerator and heater, or either, as the supply-piston moves between the supply-air and heated air, during the periods of the nearly stationary position of the working-piston.

"I also claim, in combination with the double-piston movement of each cylinder, the methods of connecting the working-pistons of two single-acting engines to constitute a double-acting engine, by means of two sets of vibratory arms attached to each other, and vibrating on a common center connected with the two working-pistons, and with the two cranks on opposite sides of the crank-shaft, the two sets of arms acting on the principle of the bent-lever, and the crank-shaft being so located relatively to the cylinders and the centers of vibration of the arms, substantially as described, that the working-piston shall be at the end of its inward stroke at the time the crank is passing the dead point farthest from the point of connection of the connecting-rods with the vibrating-arm, as described, by which the power of that working-piston which is being impelled by the heated air is applied to the best advantage to operate the other working-piston during its return-stroke, and by which also the working-piston remains nearly at rest during the time the supply-piston is making that part of its outward stroke, during which the partially compressed air is finally and fully compressed and transferred to the regenerator and heater, or either, as described."

Since the experiments on a large scale, a smaller size of the Ericsson engine has been made efficient.

An Englishman, who was deputed to examine the engine, made a published report in which the following is found: —

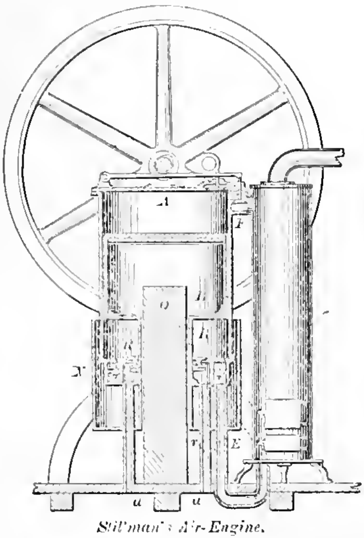
"They all gave complete satisfaction and apparently ample power for the purposes to which they were applied; but without experiment it is impossible to say what quantity of power they actually furnish respectively, but, judging by the appearance of things, they all worked well and with surprising regularity, evidently developing a much larger amount of power from a given quantity of coal than could be obtained from steam-engines, as at present constructed, of corresponding powers. And being such that they may be placed in any location from which a chimney may be reached, and not requiring water or skilled attendance, they are particularly desirable as a driving power for small manufacturers, who are thereby enabled to conduct their operations in the business parts of the cities, by occupying upper lofts.

"No attention is required for them while running, beyond what is necessary to throw in a few coals occasionally, which is all that is required to keep up a constant and uniform motion, — which considerations become of importance to those who require a small power only.

"As to the appreciation of this machine by the public, it may well be said that whereas it was a few years ago looked upon as a mere mechanical curiosity, it is now regarded and acknowledged as a reliable motive power."

The "London Engineer" adds: "That it is possible to construct an air-engine which will burn less coal than an average steam-engine has been almost proved, but it is wrong to argue from this that the steam-engine is 'used up.' Something more is wanted than economy of fuel. We need permanence, absence of wear and tear, compactness, simplicity, and safety. In every one of these points, except perhaps the last, hot-air engines cannot bear a moment's comparison with the steam-engine. No large hot-air engines have ever been constructed and worked with success. The rubbing surfaces must be huge, and an efficient lubrication becomes an impossibility, hence friction is enormous. The dimensions of the working parts must be very great, or the temperature of the air very high. Surfaces nearly red hot cut into each other, and friction runs away with the power of the machine, the destruction of which is imminent each day. Considerable improvements may be effected in lubrication, but experience with the steam-engine conclusively proves that the limit of temperature consistent with practical working is very soon passed. It is not safe to use superheated steam much hotter than 250 degrees, the cast-iron of the cylinders and valve faces becoming disintegrated and spoiled at higher temperatures. If air of no greater temperature is used, we have an effective pressure of not more than 7 lbs., or thereabouts, per square inch. Marine

Fig. 85.

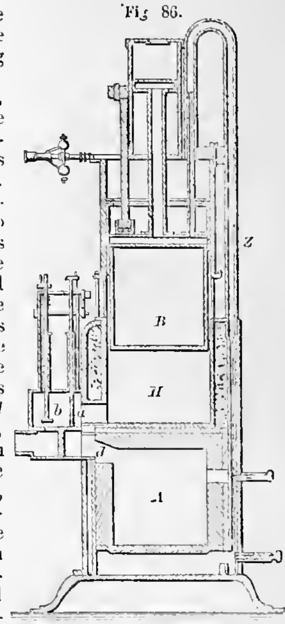


Stillman's Air-Engine.

engines with cylinders of 100 inches in diameter must be replaced under such a condition with others of 15 feet or 16 feet in diameter. Then would come huge air-pumps and regenerators. The machinery would take up as much space as boilers and steam-engines together; and all this to save perhaps a quarter of a pound of coal per horse per hour."

Stillman, June 26, 1860. The air is compressed and worked in a single cylinder by a single piston. The air is compressed in the space below the piston *B*, passes by pipe *E* to the heater, and thence by valve *F* to the effective space *A* above the piston. As the piston rises, air is drawn in between the hollow piston-rod *B'* and the plunger *O*, cooling the former, and is ejected again as the piston descends. The induction-air enters at pipes *a a*, as the piston rises, the annular valve *R* being raised by the friction of its stuffing-box upon the hollow piston-rod *B'*. The cylindrical chamber *X* is attached to the piston-rod *B'*, and rises and falls therewith so as to alternately draw and expel air through the annular space between it and the cylinder, for the purpose of cooling the latter.

Fig. 86.

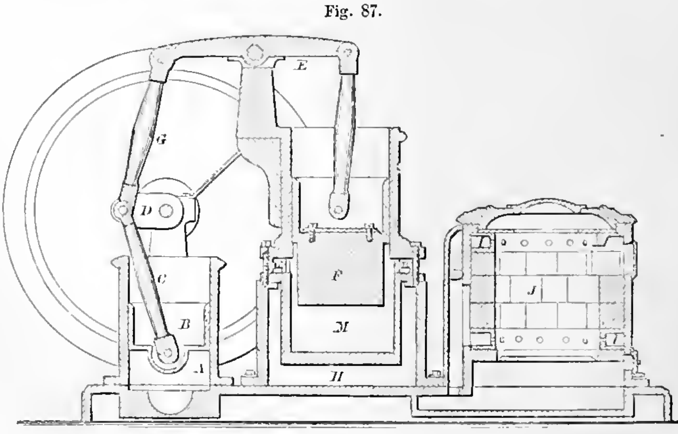


Roper's Air-Engine.

Roper, June 9, 1863. The furnace is lined with fire-brick on all sides except the bottom. The air is condensed in the pump above and passes down by the pipe *Z*, being admitted above or below the grate in quantities proportioned to the requirements of the fuel. The air passes from the furnace *A* by an opening *d*, and is admitted, on the rising of valve *a*, to the space *H*, when it is rendered effective against the piston *B*. The exhaust-valve *b* is raised to allow the descent of the piston, the valves being automatically worked by the usual means, and the cut-off being adjustable as required.

Baldwin, February 14, 1865. In this engine the air is driven out of the force-pump *A* by the descent of the piston *B*, which is connected by pitman *C* with the crank *D*. The air from the pump *A* passes, by passages *H*, to the tuyeres *I* around the furnace *J*, into which it issues by a series of openings on the inner faces of the annular tuyeres. These air-passage rings are interchangeable with the movable rings which form the lining of the furnace. The air passes from the primary to a secondary furnace, and thence by passages and valve-ways to the working-cylinder *M*, where it

Fig. 87.



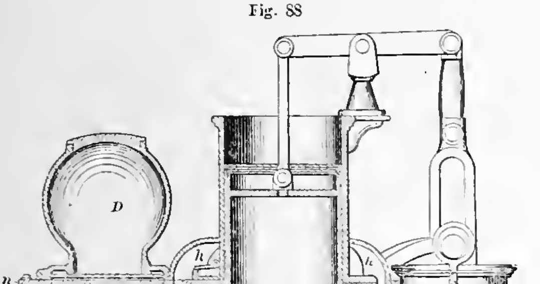
Baldwin's Air-Engine.

acts upon the piston *F* to raise the walking-beam *E*, and the latter connects by pitman *G* with the crank *D*.

The disk-valves are made of flexible material, and are guided by marginal, vertical pins, which form a cage to restrain the disks from lateral movement, but permit free, vertical play. The air, after expanding in the working-cylinder, becomes sensibly colder and is exhausted into the atmosphere. A connecting-rod eccentrically journaled to the main-shaft operates toes which trip the inlet and exhaust-valves of the working-cylinder.

MESSER, March 7, 1865. The cylinder *A*, air-pump *b*, and furnace *C* are on a plane, and the feed-box *D* over the latter. The packed portion of the piston works in the upper part of the cylinder, which is cooled by air in the passage *h*, leading from the air-pump to the furnace. A check-valve in the passage prevents the reflux of air. The foundation-plate of the engine has high sides *m*, and forms a water-reservoir in which steam is generated by radiation from the furnace-walls. A top-plate *n* forms the top of the reservoir, and the cylinder is protected by a double wall which prevents immoderate subtraction of heat therefrom. Air from the pump circulates through the hollow grate-bars. A pump is provided for injecting combustible fluid, to

Fig. 88



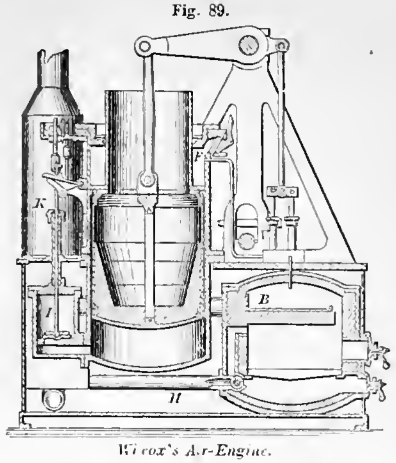
Messer's Air-Engine.

mix with the solid fuel in the furnace, and all the volatile products of combustion are passed through the working-cylinder, the induction and eduction valves being worked in the usual manner.

WILCOX, May 16, 1865. This engine is substantially on the principle of the engine of Sir George Cayleys (about 1830). The fire is fed with air, under pressure of a pump, and the volatile products of combustion are passed through the working-cylinder

With each descent of the piston air is drawn through the inhaling valve *F*, and fills the space above the piston. On the ascent of the valve the air is driven through the regenerator, and becomes partially heated by contact with the ducts carrying out heated exhaust-air. It thence passes by pipe *H* to the furnace, a part entering above and a part below the grate as regulated by the faucet-valve. This valve is worked automatically by a thermostatic arrangement, so that when the fire becomes unduly heated the supply driven *through* the fuel is decreased and combustion checked. The compressed and heated air thence passes, by pipe *B*, to the

Fig. 89.



Wilcox's Air-Engine.

valve-chest *I*. The raising of the valve admits air to the effective space below the piston, and closes by the tripping of the adjustable cut-off arrangement; this is effected late or early in the stroke, as may be required.

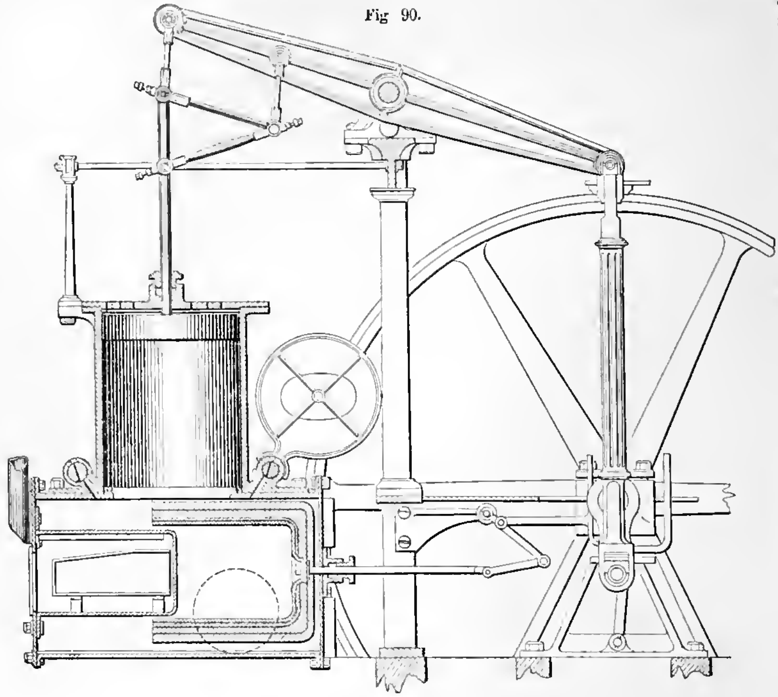
The doors of the furnace and ash-pit are secured by cramps and hollow bolts to the walls, and are removable to replenish the fuel, or for grinding or packing to make an air-tight joint.

2. The second class is as the principle of the English patents of Glazebrook, 1797; and Parkinson and Crosley, 1827.

LAUBEREAU, April 10, 1849; patented in England, 1847. This engine is the first which embodies the peculiar features of a furnace in the air-heating chamber, and a hollow plunger of corresponding form.

The air is alternately dilated and contracted by absorbing and giving out caloric, the air when separated by heat forcing up a piston in a cylinder, which is in turn forced down by the pressure of the atmosphere when the air is condensed by the abstraction of heat, the air for the alternate dilatation and contraction being carried over a heating and cooling surface by the motion of a plunger in a cylinder that communicates with the cylinder of the engine. The plunger is made hollow, with its external and internal surfaces made of some good conductor of caloric separated by a non-conductor, the said plunger being adapted to move within a surrounding cooling-vessel and so combined with a heating-vessel made of some good conductor of caloric, and heated by the application of heat internally, that the said hollow plunger shall alternately cover and uncover it, and thus cause the contained air alternately to pass over the heated surfaces to dilate it, and then over the cold surfaces to contract it, the said surrounding vessel being in connection with a cylinder to which is adapted a working-piston. The operation is as follows: before heat is applied, air is admitted, under the pressure of the atmosphere, through one of the valves or cocks; fire is then made in the furnace until the contained air is dilated; a portion of which is then permitted to escape through one of the valves or cocks, which is then closed. The heat is then continued until the air has acquired sufficient elasticity to force up the piston. This communicates motion to the crank-shaft, and toward the end of the upward motion of the piston, the cam on the main shaft moves the plunger until it covers the heater, and this motion of the plunger

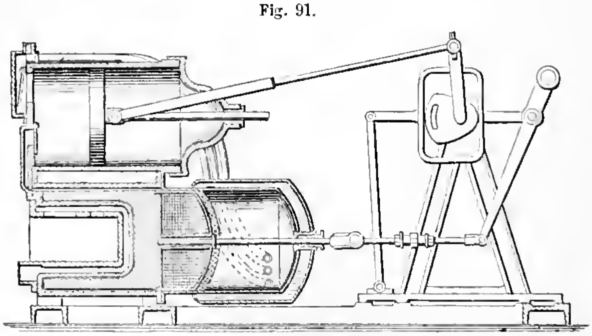
Fig 90.



Laubereau's Air-Engine (1847).

causes the air contained between it to pass between its outer surface and the inner surface of the surrounding vessel, and to accumulate at the back end of the plunger, so that, the heat being entirely shut in, the air is cooled by contact with the cold surface of the surrounding case and outer surface of the plunger, the air thus contracted producing a partial vacuum which permits the piston to be forced down by the pressure of the atmosphere above. As the piston approaches the end of its downward stroke, the cam moves back the plunger, which transfers the cold air from the outside to the inside, thus causing it to pass in a thin film over the surface of the heater and the inner and heated surface of the plunger. It is thus again dilated, that by its elasticity it may again force up the piston.

Fig. 91.



Laubereau's Air-Engine (1859).

In this way each stroke of the plunger causes the air to pass over the heated surfaces to dilate it, and then over the cold surfaces to condense it. The plunger also has the effect to shut in the heat of the heater, receiving heat therefrom in the mean time while its external surface is kept cold by the surrounding case, the non-conductor interposed between them preventing the heat of the internal surface from being transmitted to the external surface.

This engine has been since modified (patent in England, July 22, 1859) by the introduction of a valve in the passage between the heater and working-cylinder, and at the eduction from thence into the pipes which conduct the air back from the working-cylinder to the cool end of the chamber.

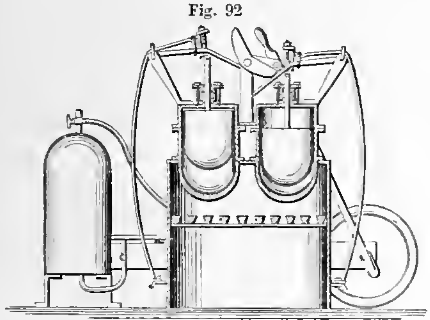
This air-engine is said to be coming into great favor on the continent of Europe, and in the later form is very compact. The operation of the engine is so similar to the preceding that it does not call for a lengthy description. The jacket around the cool end of the air-chamber has a current of water, or some other means of refrigeration, so as to render it more prompt and effective in its action on the air. The working-cylinder is connected alternately to the respective ends of the chamber below, by passages whose valves open and close, according to the direction of the current.

SCHWARTZ, December 20, 1864. This invention is thus described officially: "The object of this invention is to produce an air-engine to work upon the recuperative system, and thus to use the same air over and over. Its novelty consists, first, in the generator, which is composed of a strong flat-sided vessel, with rounded neck at the top, which is suspended over the fire in the furnace. From the bottom of this generator protrude downwards several bottle-shaped tubes which are open towards the inside space of the generator. This generator is filled with a liquid whose boiling-point is very high, say from 500° to 700°. The air heated in the generator passes through a pipe to the cylinder, which constitutes the second novel feature of the engine, and is composed of three distinct parts, the central one of which is the working-cylinder, the end ones being filled with small tubes, into which rods are fastened to the piston-neck for the purpose of agitating the entire body of air during the process of expansion. The third feature of novelty consists in passing the gas, after it has expended its force upon the piston, through the generator, which is constructed rectangularly, and has a dividing plate in its center. This vessel is filled with horizontal tubes, which are closed at both ends, and are partially filled with a fluid which is designed to extract the heat from the air or gas as it passes from the engine, and transmits it to the air which is passing to the opposite side of the piston."

3. The third class is on the principle of the Stirling engine, described in a preceding portion of this article.

PETERS, November 18, 1862. The air is heated

Fig. 92



Peters's Air Engine.

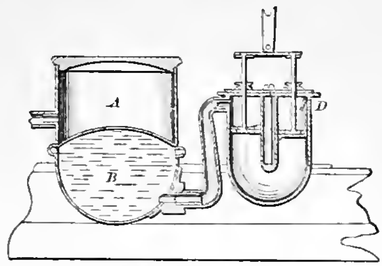
in two vessels connected with two opposite ends of the working-cylinder, and the invention consists in so operating the two plungers that the one in either heating-vessel is stationary in its uppermost position, with the space below it full of heated air, while the working-piston is making the stroke from the end of the cylinder in connection with that vessel, the plunger in the other heating vessel making both its upward and downward stroke in the mean time, and causing the latter vessel to be filled with heated air to produce the return stroke of the working-piston. The gland which is used to compress the packing in the stuffing-box is made with a deep cup in its upper part for the reception of oil, and around the upper edge of this cup is secured a leather collar in close contact with the plunger-rod, so as to prevent the escape of air.

The engine of NAPIER AND RANKINE, patented in the United States, September 19, 1854, and in England June 9, 1853, is of this class.

4. The fourth class includes those which use steam to lubricate the parts; an example will be given, but it is not to be inferred that it is confined to one. The immense expenditure of grease has induced the use, in many or perhaps most of the air-engines, of moistened air as suggested by Glazebrook 1797, Oliver Evans about the same time, and by Bennet 1838.

BICKFORD, June 6, 1865. The air is compressed in the reservoir by an annular piston; entering at the valve *D* during the down stroke, and passing through the piston during the up stroke. It is moistened by passing through a body of water *B*

Fig. 93.



Bickford's Air-Engine.

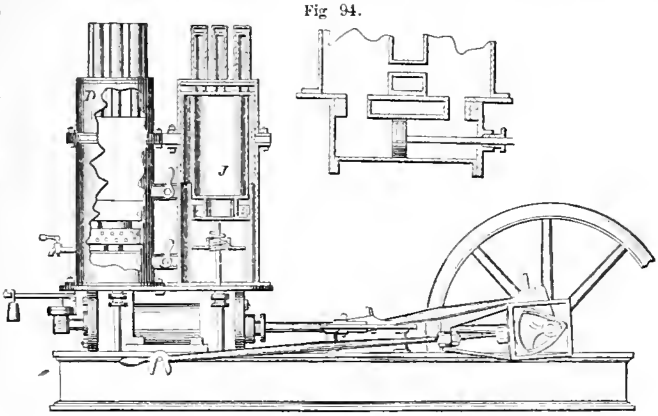
before reaching the compressed-air reservoir *A*. See AËRO-STEAM ENGINE.

5. Of the fifth class is the patent of SHEARER, September 3, 1861; in which two cylinders are used with two pistons, the faces of which are in contact with water, which is caused to pulsate by the action of bodies of air. The air is acted upon alternately by heating and refrigerating means.

KRITZER, July 29, 1862. This invention also belongs to the fifth class.

The working-cylinder, shown in longitudinal section in Fig. 94, is filled with water, which also extends into the lower portion of each of the vertical cylinders above. The lower portion of each upper cylinder forms an air-condensing space. The spaces *D*, above the pistons *J*, are the air-heating spaces where it is made effective. To the bottom of each piston is attached a sprinkling-trough of light metal, with perforated sides, so that at each descent of the piston it will be filled with water, and as it rises will distribute the same upon the inside of the cylinder.

Fig 94.



Kritzer's Air-Engine.

Air'-en'-gine, Com-pressed'. Under the headings AIR AS A MEANS OF TRANSMITTING POWER, COMPRESSED-AIR ENGINE, AIR AS A WATER-ELEVATOR, reference has been made to the use of compressed air as a motor. The devices incident to the application of the air to drive machinery have usually been of a character similar to those of a steam-engine. A piston reciprocating in a cylinder by the impact of the air admitted to the sides alternately, the induction and eduction being governed by valves.

In the Govan Colliery, Scotland, the compressed air is made to drive a high-pressure engine at the bottom of the shaft. See COMPRESSED AIR ENGINE. At the Hoosac Tunnel the drills are driven by compressed air, and the same is true of the tunneling-machine used at Mont Cenis Tunnel, lately completed. See TUNNEL.

Air′-es-cape′. An air-trap which allows air to escape from the upper bend of a water-pipe. It consists of a ball-cock, which, in falling a certain extent, opens the air-valve, and closes when the water rises to the level for which it is set.

Air′-ex-haust′er. An air-trap, by which collected air may escape from water-mains, etc.

An air-pump, or vacuum-fan, by which effete air is removed from a shaft, mine, room, or other place.

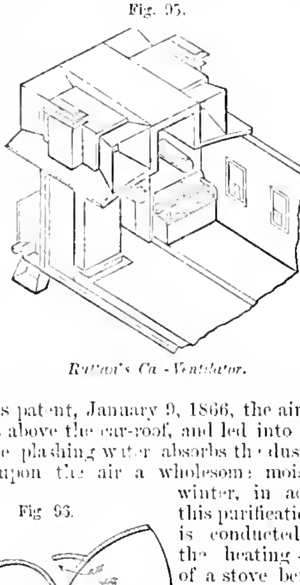
A *vacuum* ventilator in contradistinction to a *plenum* ventilator, which operates by forcing *in* air.

Air′-fil′ter. DR. STENHOUSE's air-filters were set up at the Mansion House, London, in 1854.

The mode of filtering air is by a wire screen, which arrests floating and flying bodies of any magnitude, and then exposes the current of air to the contact of water.

The most common exemplifications of the devices are to be found in the railroad-car ventilators. In

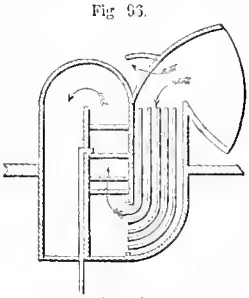
Fig. 95.



Ruttan's Car-Ventilator.

RUTTAN's patent, January 9, 1866, the air is caught by hoods above the car-roof, and led into a chamber where the plashing water absorbs the dust and also confers upon the air a wholesome moisture. In winter, in addition to this purification, the air is conducted through the heating-chambers of a stove before being disseminated inside the car.

Fig. 96.

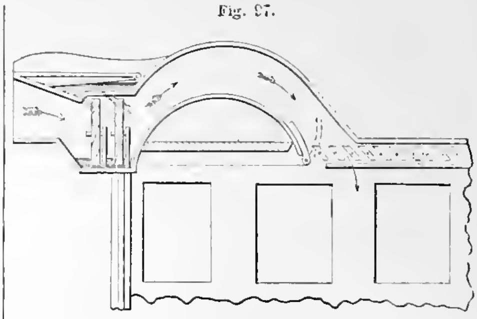


Medcalfe's Air-Filter.

MEDCALFE's apparatus for ventilating railroad-cars, January 22, 1856. The current of air is received by a self regulating bonnet on the roof, and conducted by several passages to a water-chamber, whence it passes through a number of fixed wire screens before reaching the interior of the car. The air is carried into the car through registers or by pipes around the stove. From the car it passes through a similar apparatus, devoid of water.

BAUSMAN, April 9, 1861. In the upper part of either end of and extending across the car is placed a trunk or box, having near its orifice a depression which forms a water-chamber, in which are mounted a series of fans, so arranged as to be set in motion

Fig. 97.

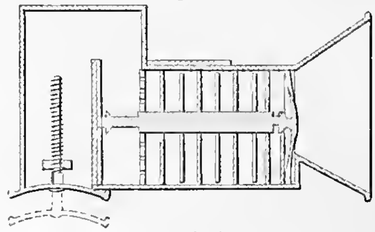


Bausman's Car-Ventilator.

by the resistance of the air as the car moves along. Above the fans is a water-chamber, the bottom of which is perforated to allow the water to drop on the fans. In the rear of the trunk is a register for admitting air to the car, the air being divested of dust in passing through the spray caused by the operation of the fans.

FURNIS, September 17, 1861. Arranged within the flaring mouth of a case is a wind-wheel connected with a shaft. Upon the shaft are secured a series of radiating arms and a perforated disk, which re-

Fig. 98.

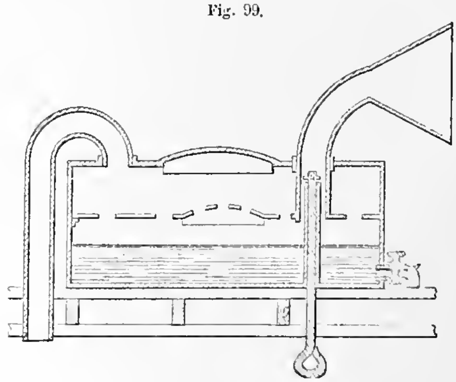


Furnis's Ventilator.

volves in a water-chamber as the car moves along, so that the particles of dust coming in contact with the arms will adhere to the same, and the air enter the car in a cool and pure state.

BEARDSLEY, October 29, 1861. A galvanized iron case contains a reservoir and a perforated plate, and is provided with a funnel-shaped tube, which passes into the ventilator a little below said perforated plate. Another tube passes through the car and enters the top of the ventilator. The funnel-

Fig. 99.

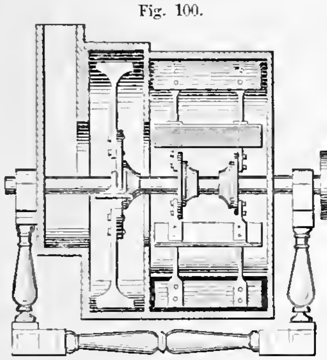


Beardsley's Car-Ventilator.

shaped tube by which the air enters the ventilator is adjusted by means of a rod passing through the top of the car, the open end being turned in the direction in which the car is moving; the other tube receives the foul air from the car, whence it passes through the ventilator. By reversing the funnel-shaped tube the air is ejected from the car. Cinders and dust are prevented from entering the car by coming in contact with the tube, which is surrounded with water.

In WHELPLEY AND STORER'S apparatus for removing dust and gases from air, March 6, 1866, the spray-wheel and the draft-wheel are placed in separate and communicating chambers. The object is to remove the dust and gases from air which issues from the pulverizers and the chimneys of furnaces for

Fig. 100.

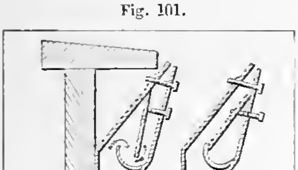


Whelpley and Storer's Draft and Spray Wheel.

reducing metal. The air is admitted by the trunk into the chamber, where it is exposed to a dash of spray from the wheel, and thence passing to the fan-chamber is subjected to jets of liquid, chemically prepared to act upon the gases present. The jets proceed from the hollow shaft, which is pierced with holes for that purpose.

HERRON, January 12, 1858, attaches to the pulpit or rostrum an air-pipe by which a supply of fresh, pure air is afforded to the speaker. The air in its course is passed through a trough and beneath a plate which forms a trap. Water in the trough imparts moisture to the air, and at the same time arrests dust and such extraneous matters or vapors as are soluble in water. The latter may be medicated to impart the desired quality to the reader or speaker, and the valve is adjustable to permit the free exit or turn the current through the water-trough as may be required.

Fig. 101.



Herron's Pulpit-Ventilator.

Air'-flue. A tube by which heated air is conveyed into an apartment.

Air'-foun'tain. A contrivance for producing a jet of water by means of compressed air.

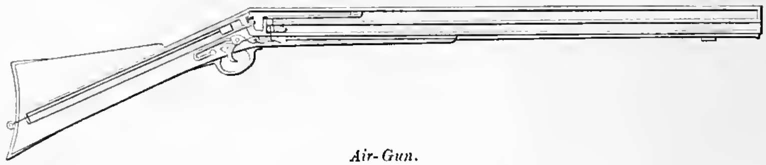
Air'-fun'nel. A cavity formed by the omission of a timber in the upper works of a vessel, to form a duct for the admission of pure air and the escape of foul.

Air'-fur'nace. A term used to signify a furnace having a natural draft, no blast.

Air'-grat'ing. An iron grating in a wall, to allow ventilation.

Air'-gun. The air-gun is a pneumatic engine for firing bullets or other projectiles by force of compressed air. The child's popgun illustrates the principle of the air-gun: a pellet is forced through a tube or quill by a rammer from the larger to the smaller end, where it sticks fast, and another pellet is put in and pressed forward in the same manner, condensing the air between them, when the pressure on the first pellet overcomes its frictional adherence to the sides of the tube, the pellet is released, and is projected by the force of the expanding air. The ancients were acquainted with some kind of an apparatus by which air was made to act upon the shorter arm of a lever, while the longer arm impelled a projectile; and it is said that Ctesibius of Alexandria, a celebrated mathematical philosopher, who lived B. C. 120, constructed an instrument in which the air, by its elastic force, discharged an arrow from a tube. (Montucla, "Histoire des Mathématiques," Vol. I. p. 267.) The first account of an air-gun is found in David Rivault's "Elémens d'Artillerie." He was preceptor to Louis XIII. of France, and ascribes the invention to a certain Marin of Lisieux, who presented one to Henry IV. of France, about A. D. 1600. An instrument of this kind was invented by Guter of Nuremberg about A. D. 1656. Various shapes have been adopted, from that of the ordinary musket to a gun resembling a common, stout walking-stick. It consists of a lock, stock, barrel, and ramrod; and is provided with proper cocks for filling it with compressed air by means of a force-pump. The lock is only a valve which lets into the barrel a portion of the air compressed in a chamber in the stock when the trigger is pulled. The gun is loaded with wadding and ball in the ordinary way, and when fired there is but little noise, and none of the other concomitants of gunpowder, smoke and odor. The usual range to which the air-gun propels a bullet is from sixty to eighty yards. In those guns having a sliding trigger, two or three bullets are successively and separately introduced, and may be expelled by one mass of condensed air. Air-guns have also been constructed upon the principle of revolving pistols, admitting the expulsion of several bullets after once charging with compressed air. Some varieties have an air-pump attached by means of which a more powerful compression of air may be produced. One air-gun in the form of a cane has two barrels, — one small one for the reception of bullets, and one large bore for the reservoir of compressed air. Elastic springs have also been used in connection with compressed air, but the latest improvements are those of Cornelius Borda. The reservoirs of the gun are filled with a mixture of oxygen and hydrogen in due proportion for producing water. The gun is provided with a small electric battery connecting with the trigger. The moment a portion of the gas is let out, an electric spark is produced, occasioning the instantaneous combustion of the mixture, and a high pressure in consequence of the excessive heat resulting from the chemical transformation. This gun is said to propel a bullet as far as an ordinary musket. The noiselessness of ordinary air-guns is accompanied by slight projectile force, and the gun of Borda in exploding a body of gases in confinement would probably cause as much sound as the combustion of gunpowder in quantity sufficient to generate the same projective force. SHAW'S air-gun, patented in 1849, combines an endless band of vulcanized india-

Fig. 102



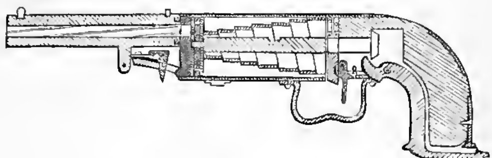
Air-Gun.

rubber with an air-exhausting apparatus; the electricity is so applied as to compress the air at a single stroke of the air-pump the moment before it is discharged. The steam-gun, exhibited in London a few years ago, exemplified a much more forcible agent than air for the propulsion of bullets.

In Fig. 102 the upper chamber is the reservoir of air, which is condensed therein by means of the piston and valve in the stock. The lower tube is the barrel, and the ball is rammed down to its lower end as usual. The gun being sighted, the motion of the trigger moves the valve, which admits a body of air to the rear of the ball and expels it from the barrel.

LINDNER, December 16, 1862. The lever conforms in shape to the stock of the gun, and is the

Fig. 103

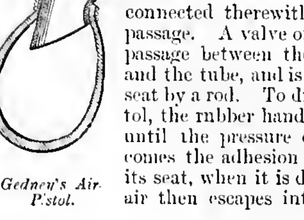


Lindner's Air-Gun.

means of retracting the piston. The piston, when released by the trigger, is driven forward by the elastic force of the condensed spring, projecting the bullet from the barrel by further compression of the air. The spring is a helical ribbon, and condenses into a simple coil when the pressure of the lever is applied. The barrel is breech-loading, tilting on a pivot so as to expose the rear for the reception of the ball, and being locked shut by a catch. A projecting india-rubber ring at the joint of the barrel makes an air-tight joint when the barrel is closed. The projectiles have an expanding portion, which enters the rifle-grooves of the barrel to increase the accuracy of the flight.

GEDNEY, September 24, 1861. The hollow handle is formed of india-rubber or other flexible air-tight material, and communicates with a short tube placed beneath the barrel and connected therewith by means of a passage. A valve of cork closes the passage between the hollow handle and the tube, and is pressed into its seat by a rod. To discharge the pistol, the rubber handle is compressed until the pressure of the air overcomes the adhesion of the valve to its seat, when it is driven back; the air then escapes into the tube and thence into the barrel, driving out the projectile. This and the preceding are only toy-guns.

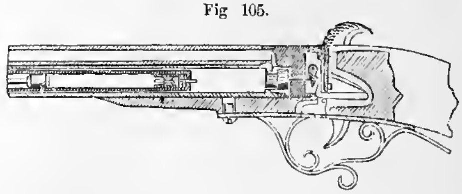
Fig. 104.



Gedney's Air-Pistol.

GIFFORD, February 9, 1864. The barrel is in communication with the inside of the trigger-box, in the interior of which is a valve-piston, consisting of a steel rod carrying a ring fitted with a caoutchouc disk for closing communication. Air enters the barrel by a bell-shaped chamber. By pressing strongly on the extremity of the rod, the disk is compressed and

Fig 105.



Gifford's Air-Gun.

closes the reservoir orifice. By suddenly releasing the piston-valve the elasticity of the caoutchouc, combined with the pressure of the compressed air, causes the sudden opening of the reservoir orifice and emits a blast of air to the rear of the projectile. The air is compressed into a reservoir beneath the barrel, by means of a piston working longitudinally in a valved interior tube, and the valvular arrangement is to give an instantaneous emission of air and an immediate closure, so as not to waste the air by a protracted opening of the valve-way.

The South American Indians of the Amazon and Orinoco use a species of air-gun or blow-pipe for propelling poisoned arrows. It consists of a long, straight tube in which an arrow is placed and expelled by the breath. Near Pará, it is very ingeniously made of two stems of a palm, of different diameters, one fitted within the other to secure perfect straightness; a sight is fitted to it, near the end. The arrows used are fifteen to eighteen inches long, having a little ball of down, from the silk cotton-tree, twisted round the smaller end so as to make it fit closely in the tube. In the hands of a practised Indian this is a very deadly weapon, and as it makes no noise he frequently empties his quiver before he gathers up his game.

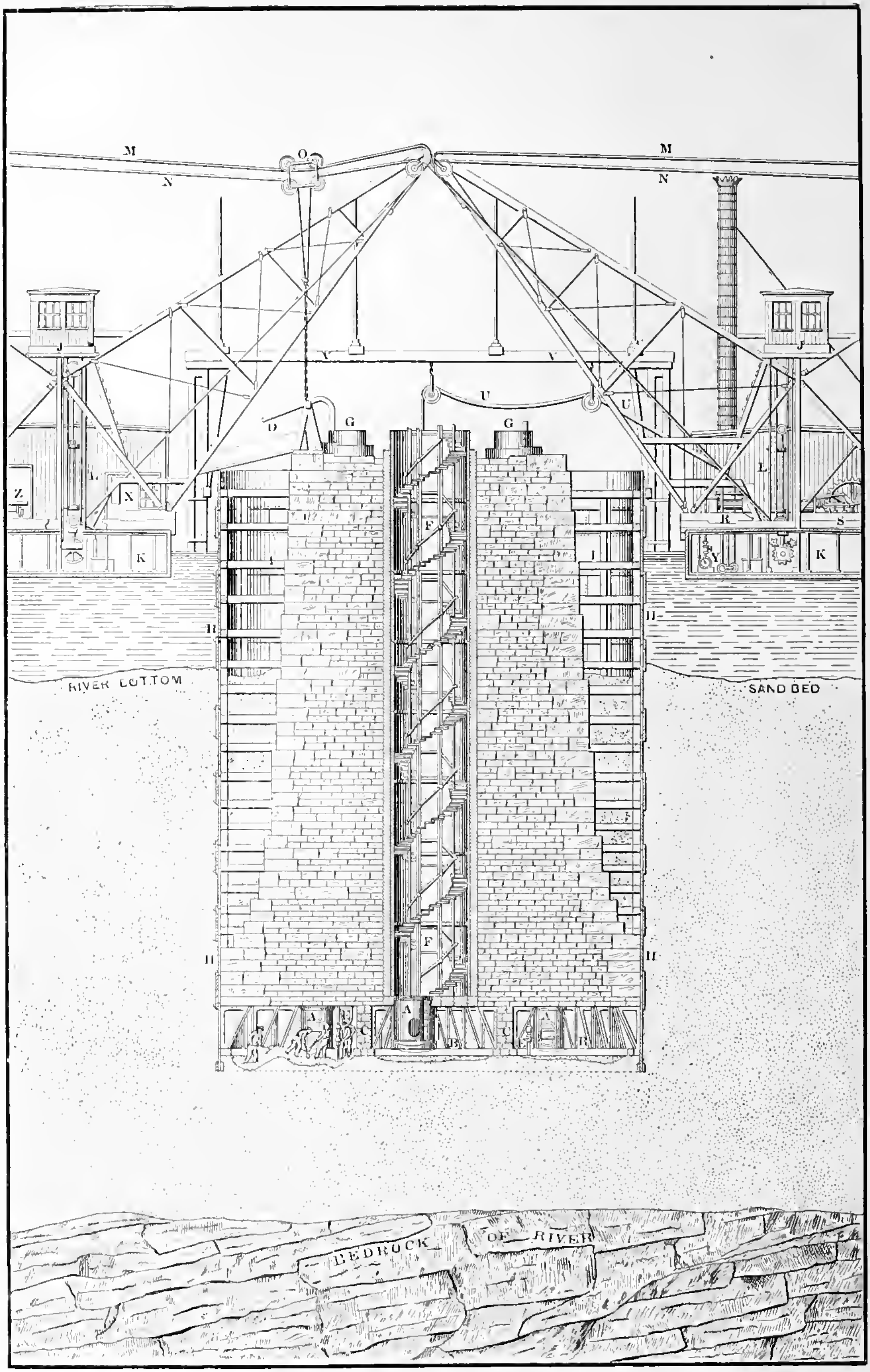
Warburton, the eminent naturalist who wandered in these countries, gives a good account of their modes of hunting. See also Humboldt, and the Researches of Sir Robert H. Schomburgk in British Guiana.

A similar weapon is found among some of the Malay tribes, and is called by them the sumpitan.

Aristotle was acquainted with the fact that the air has weight, stating that a bladder inflated with air will weigh more than an empty one; as he was not acquainted with glass globes, which can be exhausted of air without losing their shape, we may infer that his statement with regard to the bladder was intended to apply to a hypothetical one which possessed the stiffness of glass, or else that the air was considerably compressed in the inflated bladder.

Hero of Alexandria, in his "Spiritalia," shows his knowledge of the elasticity of air, and how it could be used to produce many effects. He shows the air-pump.

Ctesibus developed the pump into an air-gun.



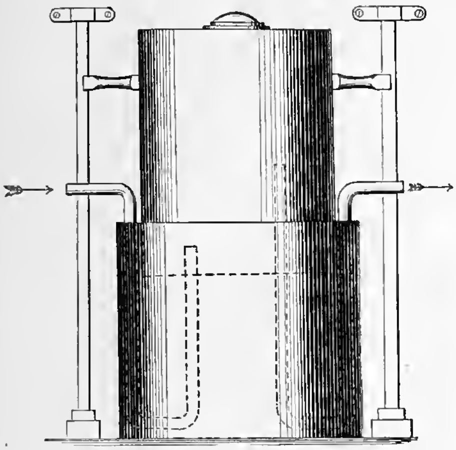
PIER AND CAISSON.

PLATE II. ILLINOIS AND ST. LOUIS BRIDGE. *See page* 49.

He was probably the tutor of Hero and the contemporary of Archimedes. Otto Guericke reïnvented and applied the air-pump; Boyle made it a valuable instrument.

Air′-heat′er. A stove or furnace so arranged as to heat a current of passing air, for warmth or ventilating purposes. See HEATING FURNACE; HEATING STOVE; HEATING APPARATUS, etc.

Fig. 106.



Air-Holder.

Air′-hold′er. A vessel generally of a cylindrical form, with its open end plunged in a tank of water, and intended to contain air or gas. Its use is common in a variety of machines and apparatus where a steady and moderate current of air is required, as in machines for carbureting air and gas, aspirators, etc. Also in machinery on a larger scale, such as blowers, ventilating-machines, etc.

The air is introduced by a bent pipe turned upward inside the tank and holder, and is educed in a similar manner. On a small scale the vessel may be charged with air by raising the upper valve and lifting the holder, and the air may be withdrawn by a flexible pipe attached to the holder. See ASPIRATOR; CARBURETING AIR; BLOWER, etc.

Air′-hole. (*Founding.*) A hole or cavity in a casting produced by bubbles of air in the liquid metal. A vent-hole in a mold for casting.

(*Furnace.*) A draft-hole in a furnace. It is sometimes guarded by a register; sometimes stopped by a luting or plug of clay.

Air′ing-stage. A platform on which powder, etc., is dried by exposure to sun and air.

Air′-jack′et. An air-tight swimming-jacket capable of inflation.

A garment with inflatable lining or pockets to serve as a life-preserver.

Air′-lev′el. (*Surveying.*) A goedetic instrument invented by M. Thevenot. The level is determined by means of an air-bubble in a glass tube nearly filled with colored spirit. Generally termed a spirit-level; though the air-bubble is the dominant feature. See LEVEL.

Air′-lock. (*Hyd. Eng.*) A pneumatic contrivance in a hollow caisson whose lower chamber is filled with compressed air to exclude the water. A trunk connects the submerged chamber with the external air, and has two valves. The descending workman enters a chamber in the tube at the atmospheric pressure; the upper valve is closed, and his apartment is charged with air from the lower chamber; the lower valve is then opened to admit him to the working-chamber.

The cut on the page opposite is a sectional view of the East Pier and Caisson of the Illinois and St. Louis Bridge, in course of construction by Captain James B. Eads, across the Mississippi. The view shows the interior of the main entrance-shaft and air-chamber, and the working of one of the pumps. The caisson is represented as having descended through 60 feet of sand, silt, and gravel which form the sand-bed of the river; 20 feet of excavation remaining before the bed-rock is reached.

The pier of masonry is built on a strong bulkhead of timber and iron, supported on a curb which rests on the sand-bed, and is strengthened and sustained by timber girders which divide the working space beneath into several chambers which communicate through holes in the partitions. The pier is enclosed by an iron envelope *H*, which is water-tight, and prevents access of water to the pier and the workmen. Until the curb of the caisson reached the sand-bed it was sustained in erect position by screws from the trusses of the guide-piles, but was afterwards preserved erect by digging away the sand equally at all the points upon which it rested. *I I* are timber braces which support the shell *H*. *K K* are pontons alongside, which support the steam-engine, air-pump, mixing and hoisting machinery, and the offices and quarters for the staff and hands. *S* is the steam-engine which drives the air-pump *R*, and the air is conducted by the hose *U* down to the chambers *B B*, where the excavating is proceeding. The sand is loosened by water and the pick, and is driven by condensed air up through the sand-pumps *E E*, which discharge at *D*. The air-locks *A A* are chambers intervening between the main entrance-shaft *F*, where the air is at the natural pressure, and the chambers *B B*, where it is in a much condensed condition. The visitor steps from the shaft *F* into the air-lock *A*, the door of ingress is closed, and condensed air is then admitted. When an equilibrium is established between the chambers *A* and *B*, the door between is opened, and the visitor finds himself on the scene of action. As the caisson descends, successive courses of stone are laid on the piers by means of traveling-purchases *O*, which move on the wire ropes *M M* by means of hoisting-ropes *N N*. *G G* are side shafts; *J J* cabins for operators of purchases; *L L* hydraulic jacks for lifting materials; *V* pipe for water to sand-pump; *V V* trusses for guide-piles; *Z* mixing-room; *X* office. See CAISSON.

Air′-ma-chine′. A machine for ventilating mines.

Air′-met′er. An apparatus for measuring the quantity of air passing along a pipe, or passing into or from a chamber.

There are various forms: the fan, rotating spiral vane, expanding bag, cylinder and piston, revolving partially submerged meter-wheel, etc. As their principal adaptation is to measuring gas, to avoid unnecessary repetition they are assembled under GAS-METER, which see.

Air′o-hy′dro-gen Blow′pipe. An apparatus invented by Dr. Hare, in which the issuing air is assisted by a jet of hydrogen to intensify the flame. See BLOWPIPE.

It is especially used in autogenous soldering.

Air-om′e-ter. The term is applied to a hollow cylinder, closed above and open below, with its lower edge plunged in a tank, and used to contain air. The term has been derived from its similarity in shape to a gasometer, the change in the first syllable indicating the different contents. Its use as a meter is unfrequent, and it is properly called an air-holder among experts. See AIR-HOLDER.

Air′-pipe. (*Steam-engine.*) 1. A small copper pipe leading from the top of the hot-well through the ship's side, for the discharge of the air and uncondensed vapor removed by the air-pump from the condenser.

2. A pipe used to withdraw foul air from or force pure air into close places.

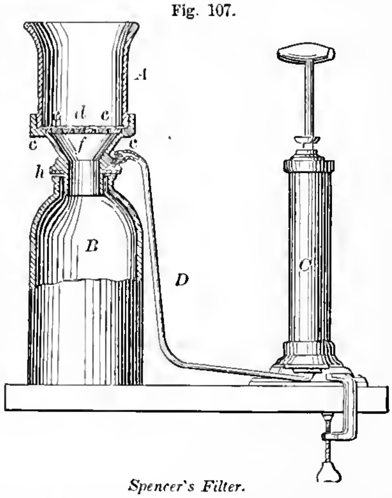
Air′-poise. An instrument to measure the weight of air.

Air′-port. An opening in a ship's side for air; closable by a shutter, side-light, or dead-light, according to circumstances.

Air′-press′-ure Fil′ter. A filter in which the percolation of the liquid is assisted by atmospheric pressure, induced by a partial vacuum in the lower chamber.

SPENCER'S air-pressure filter, June 4, 1867, is particularly adapted for the use of pharmaceutists. *C* is the air-pump, secured by a clamp to the edge

Fig. 107.



Spencer's Filter.

of the table. The filter *A* rests on a packing on the lip of the bottle *B*. The air is withdrawn from this latter to increase the rate of filtering.

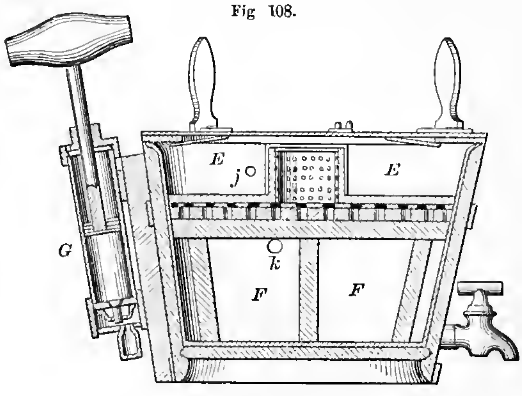
Claim.— First, in an atmospheric filter composed of the tunnel *A*, bottle or jar *B*, and air-pump *C*, the employment of a packing *h* for the purpose of producing an air-tight joint between the tunnel and bottle, the whole combined and operating as herein set forth.

Second, the arrangement of the filtering medium *d d* with the removable perforated diaphragm *f*, when operating in connection with the shoulders *c c*, as herein set forth.

D is the air-eduction pipe. The vessel *A* stands in the collar-piece *f*, the latter on the bottle, whose lip has a packing-gasket.

In GRUBER'S air-pressure filter, April 3, 1866, the filtration is assisted by an air-forcing and air-exhausting pump, connecting by pipes with the two chambers separated by the filtering substance. *j* and *k* are the openings of the plenum and vacuum pipes into the chambers *E* and *F*. The lid is fastened on, and has an air-tight packing. The pump *G* draws air from chamber *F*, and impels it into chamber *E*. For WATER-PRESSURE FILTER see PRESSURE-FILTER.

Fig 108.



Gruber's Filter.

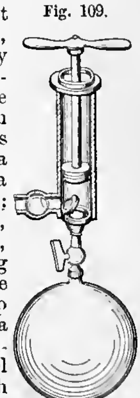
Air′-pump. Invented by Ctesibus of Alexandria, or previous to his time. Hero, of the same city, the author of the "Spiritalia," shows it in connection with several of his pneumatic contrivances. He also shows a fire-engine with a pair of single-acting pistons attached to a walking-beam and operating alternately in their respective cylinders.

February 15, 1665, Mr. Samuel Pepys, the gossiping author of the famous Diary, was admitted a member of the Royal Society, the meetings of which were held at Gresham College. He says:—

"It is a most acceptable thing to hear their discourse, and see their experiments; which were this day on fire, and how it goes out in a place where the ayre is not free, and sooner out when the ayre is exhausted, which they showed by an engine on purpose. . . . . Above all Mr. Boyle was at the meeting, and above him Mr. Hooke, who is the most, and promises the least, of any man in the world that I ever saw."

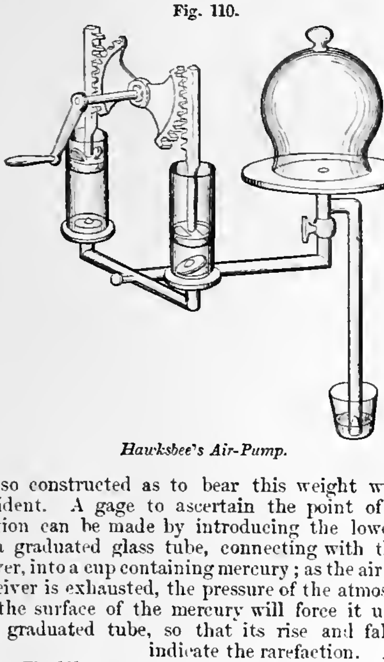
The air-pump was reïnvented by Otto von Guericke of Magdeburg, about A. D. 1650. Since then this instrument has been much improved by Hooke, Papin, Hawksbee, and Boyle. Many varieties of structure have been devised, the principle of all being the same. The basis or essential part in the air-pump is a metallic or glass tube answering to the barrel of a common pump or syringe, having a valve at the bottom opening upwards; and a movable piston or embolus, answering to the sucker of a pump, the piston or cylinder being furnished likewise with a valve opening outward. The pump must be closely fitted by a metallic connecting-tube opening into or under the vessel which is to be exhausted, which is usually formed by placing a bell-glass, called the receiver, with the edges ground smooth, and smeared with lard or wax, on a flat, smooth plate or table. When the piston is at the bottom of the barrel, and is then drawn up, it lifts out the air from the barrel; and a portion of the air from the receiver by its own expansive force passes through the connecting-tube, and occupies the place below the piston which would otherwise be a vacuum. The air in the receiver and barrel is thus rarefied; the piston is now forced down, closing the valve placed at the mouth of the connecting-tube, and causing

Fig. 109.



the air in the barrel to escape through the valve in the piston. This operation is again and again repeated until the receiver is so nearly exhausted that the elastic force of the remaining air is no longer sufficient to open the valves. The form of the pump may consist of two barrels (each having a piston) having a junction with each other at the point where the connecting-tube is attached, and operated alternately by a lever attached to each piston and supported at a point midway between them, or by means of teeth or cogs cut in the piston-rod, and operated by a cog-wheel, as shown in the accompanying figure. The valves may be made of bladder, oiled silk, or gutta-percha, the best form of which is a small hollow cone with a slight cut at the top; stop-cocks must be attached so as to control the admission of air. The pressure of the atmosphere being about fifteen pounds to every square inch of surface, care must be taken that the receiver and barrels of the pump

Fig. 110.



Hawksbee's Air-Pump.

be so constructed as to bear this weight without accident. A gage to ascertain the point of rarefaction can be made by introducing the lower end of a graduated glass tube, connecting with the receiver, into a cup containing mercury; as the air in the receiver is exhausted, the pressure of the atmosphere on the surface of the mercury will force it up into the graduated tube, so that its rise and fall will indicate the rarefaction. A perfect vacuum can never be made, for it is evident that the exhaustion can never be complete; even theoretically, there must always be a portion of air left, though that portion may be less than any assignable quantity. Many useful and interesting experiments can be performed with the air-pump, illustrating the effects of atmospheric pressure and other mechanical properties of gases.

Fig. 111.

Siemen's Air-Pump

In SIEMEN's air-pump the two cylinders or barrels differ in size and arrangement. The smaller barrel is applied either to the bottom or top of the larger, while the valved pistons belonging to each are attached to one and the same piston-rod. The air withdrawn from the receiver is condensed in the lower cylinder to one fourth of its original volume, and thus has sufficient elasticity to pass through the discharging valve and escape, the opposing pressure of the atmosphere on that valve being thus counteracted from within.

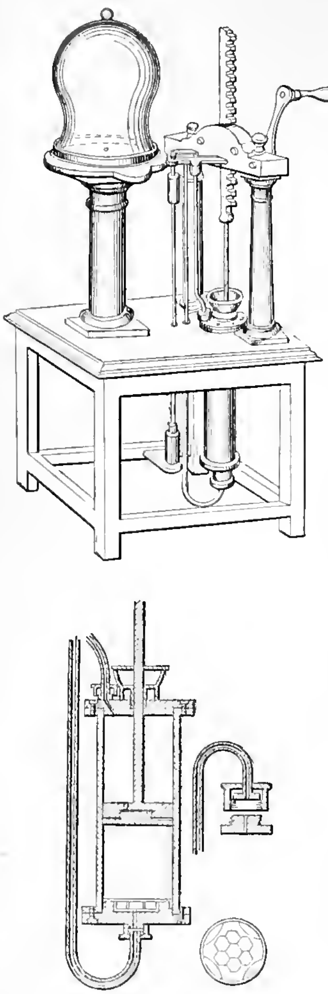
In the illustration, *A* is the exhausting-cylinder, *B* the second cylinder, equal in length to the first, and fixed to its lower part, but having only one third or one fourth of its sectional area, and consequently one third or one fourth of its cubical contents. The cylinders are separated by a plate forming at once the bottom of the upper and top of the lower cylinder, the only passage between them being a silk valve *v'*. In each cylinder works a valved piston, *P* and *p*, attached to a piston-rod common to both, and passing through a stuffing-box in the plate. The distance between the pistons is such, that when *P* is in contact with the top of the upper or exhausting cylinder *A*, *p* is in contact with the top of the smaller or lower cylinder; and when *P* is in contact with the bottom of the large cylinder, *p* is in contact with that of the small cylinder. The table or pump-plate *E*, placed above the large cylinder *A*, supports the receiver *R*, or other vessel to be exhausted, from which the air flows through the valve *v*, during the descent of the piston. The motion of the pistons is effected by means of a short crank with a jointed connecting-rod, converting the circular motion given by the lever-handle into a vertical one, which is maintained by means of a cross-head, with rollers working between guides. The action of the pump is as follows: The descent of the piston *P* tends to produce a vacuum in the exhausting-cylinder *A*, by causing a difference of pressure above and below the first valve *v*, in the top of *A*, so that the elasticity of the air in the receiver causes it to pass through the valve *v*. At the same time the air below *P* is pressed through the valve *v'*, in the plate which separates the cylinders, and enters *B*, in which a vacancy is simultaneously made for it by the descent of the piston *p*; and in consequence of the difference of capacity of the two cylinders it becomes reduced to one fourth of its original bulk, its elasticity being proportionally increased. The air contained in the small cylinder below the piston *p* will in like manner be pressed through the valves *v'' v'''* into the external atmosphere. During the ascent of the pistons the valves *v v'* will be closed and *w w'* opened by the downward pressure of the air in the cylinders, and *v'' v'''* will be closed by the atmosphere, thus allowing the air in each cylinder to pass through the pistons as they rise, in order that in the following downward movement the air, which during the previous stroke of the pump issued from the receiver into the exhausting-cylinder, may be withdrawn from that into the lower cylinder, while the air condensed in the latter may be finally expelled into the atmosphere. See AIR-COMPRESSING MACHINE.

The air-pump of Boyle was inconvenient, as it demanded alternate opening and shutting of the stop-cock and valve, and difficulty was also experienced in making the piston descend when the air within the pump was greatly rarefied.

HAWKSBEE's air-pump, previously cited, had the duplicate cylinders, with pistons which were moved by means of a crank and pinion. The piston-rods were toothed racks, which were engaged by the pinion, to which a reciprocating rotary motion was imparted. The bottom of each cylinder communicated by a pipe with the receiver on the platform.

SMEATON's air-pump was an improvement on Hawksbee's in two respects. Hawksbee had found considerable difficulty in opening the valves and ex-

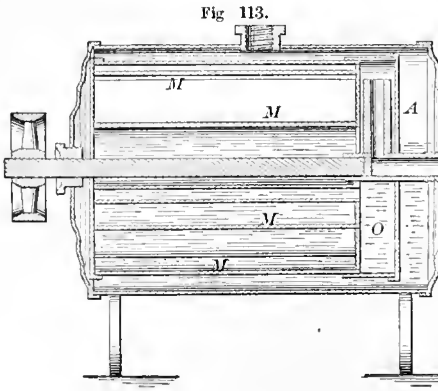
Fig. 112.



Smeaton's Air-Pump.

hausting the air at the bottom of the barrels, owing to the fact that the pistons did not shut down close on to the bottom. The first defect arose from the smallness of the orifice in the bottom of the cylinder through which the air entered; the bladder being kept moist with oil adhered to the metal and resisted the upward pressure at so small an opening. This defect Smeaton cured by exposing a greater surface of bladder to the upward action of the air. He used a congeries of holes consisting of six hexagonal openings surrounding a central one. The partitions between these holes were filed nearly to an edge, and the whole formed a grating on which the bladder-valve lay, offering but slight cohesive opposition to the raising of the valve as the piston ascended and the air from the receiver pressed upward against it.

Fig 113.



Rotary Air Pump.

To prevent lodgment of the air in the lower part of the barrel, he removed the external pressure from the piston-valve, by making the piston move through a collar of leather, and forced the air out by a valve applied to the plate at the top of the barrel, which opened outwardly.

Cuthbertson of Amsterdam introduced the improvement of mechanically opening an escape for the air without depending upon its elastic force to open the valve leading to the cylinders.

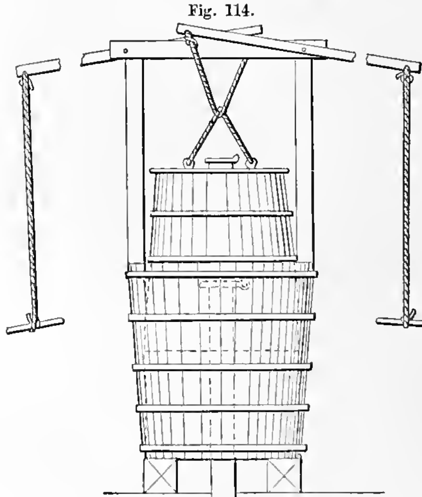
Air force-pumps are used for the supply of air-carbureting machines. A common form of these consists of what is called a meter-wheel, from its resemblance to the measuring-wheel of a gas-meter. Fig. 113. In the illustration the buckets *M* are curved, and gather in the air of the chamber *A*. As the wheel rotates the air is discharged, near the axis, into chamber *O*, and is conducted by a pipe to the hollow trunnion through which it is discharged.

Another form of air-pump used in carbureting-machines is on the principle of the gravitating air-holder, which consists of a weighted inverted cylinder whose lower edge is submerged in a tank. See AIR-HOLDER.

A conversely acting device on a larger scale is used for pumping air from mines.

In the *Annales des Ponts et Chaussées*, an air-pump

Fig. 114.



Ventilating Air-Pump

is described, used to ventilate a shaft 5 feet in diameter and 220 feet deep. The work had been several times suspended, owing to the accumulation of carbonic acid gas, and the ordinary bellows had been found ineffectual.

A large tub (Fig. 114) was firmly placed on balks on a level with the top of the shaft, and filled with water nearly to the brim.

An air-tight pipe from the bottom of the shaft was brought through the tub, and had its upper edge a very few inches above the water; it had a valve on the top.

A smaller tub, reversed, was suspended within the lower tub by cords, which were made fast to the ends of the levers.

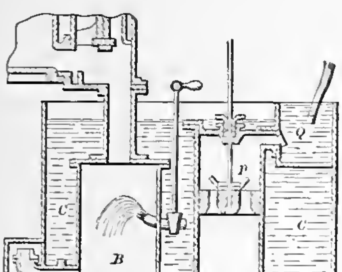
The upper tub had a very short pipe at top, with a valve opening upward.

The upper tub being allowed to descend by its own weight, the air within it was expelled through the upper valve; when again raised, by pulling the handles attached to the ropes, the air was drawn up through the valve-way at the upper end of the descending tube, and by continuing this reciprocating action, a circulation was created at the very bottom of the shaft.

Bunsen's air-pump is a means of withdrawing air by entangling and carrying it with a falling body of water. It is specifically known as an aspirator in its uses to obtain atmospheric pressure in filtering, in removing effete or poisonous air from apartments or the vicinity of gangrenous wounds. See ASPIRATOR. The same principle is involved in the "water-pumps," so called, which withdraw the air and steam from the evaporating and vacuum pans of sugar-refineries, the injection-chamber of the condensing steam-engine, etc. Air-pumps are also constructed to act on the principle of the Giffard Injector, the active column being a body of water or steam. See STEAM-JET; EJECTOR.

Apparatus for compressing air as a motor, as a water-elevator, etc., are considered under several heads. See AIR AS A WATER-ELEVATOR; AIR-COMPRESSING MACHINE; AIR AS A MEANS OF TRANSMITTING POWER; AIR-ENGINE, etc.

Fig. 115.



Air-Pump.

2. (*Steam-engine.*) A pump used in condensing steam-engines to remove the air and uncondensed steam from the condenser in order to perfect the vacuum therein, and in the cylinder to which it is periodically connected.

B is the injection-chamber, which is submerged in the cistern *C*. The uncondensed gases and water escape by the valve-way *G*, called the foot-valve, and ascend through the valve of the pump-bucket *p* as the latter descends. The next ascent of the bucket drives them out at the valve-way *Q* into the hot-well.

Air-reg'u-la'tor. A contrivance for determining the quantity of air admitted in a given time.

Registers and dampers are the usual devices; the former has usually a sliding and the other an oscillating motion. Furnaces, stoves, ovens, etc., are usually furnished with some means for regulating the supply of air; when the heat of the stove is made to regulate the register the device is called a THERMOSTAT (which see).

Air-regulators may be made to act on the principle of the gas-regulator, the degree of pressure determining the area of the opening, so that a given quantity may pass in a given time irrespective of the pressure.

Air'-scut'tle. (*Ship-building.*) An opening in a ship's side for the admission of air, closed in stormy weather by a shutter.

Air'-shaft. A shaft in a mine, usually vertical, or nearly so, by which the mine is ventilated.

Air'-spring. An elastic device depending for its action upon the tension of an imprisoned body of compressed air.

Air-springs have been made to act as brakes, to receive recoil of guns, as buffers, and for other purposes. See PNEUMATIC SPRING.

Air'-stove. A heating stove which is employed to heat a stream of air directed against its surface. Of this class are *Heating Furnaces*, and some kinds of *Heating Stoves.*

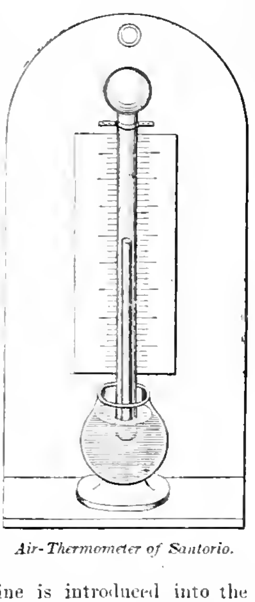
There are two common forms, with a great variety of each: —

1. The furnace such as is used in churches, large halls, and some dwellings; consisting of a stove surrounded by a casing of metal or brickwork, into which the air is led, and from which, after being heated, it passes by air-ducts to the apartment. See HEATING FURNACE.

2. A stove, a part of whose interior is occupied by passages in which air circulates against the fire-chamber and back, after which it is discharged into the room. See HEATING STOVE.

Air'-ther-mom'e-ter. An instrument in which the contraction and expansion of air is made the measure of temperature. It differs from the ordinary thermometer, which depends on the contraction and expansion of liquid in an hermetically sealed tube. The air-thermometer is the older form, and its invention is variously ascribed to Drebbel of Holland, about A. D. 1600; to Galileo; and to Santorio of Padua (1561–1636). The instrument was constructed as follows: The air in a tube being slightly rarefied by heat, the lower end was plunged into a colored liquid, which, as the air cooled, was drawn into the tube. The expansion and contraction of the air, by changes of temperature, varied the height of the liquid in the graduated tube. It was a faulty arrangement, as changes in the atmospheric pressure would vary the result, and the truth could only be ascertained by correction with reference to a barometer.

Fig. 116.



Air-Thermometer of Santorio.

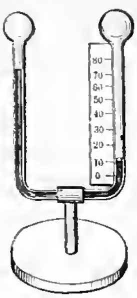
In the "Spiritalia" of Hero, B. C. 150, an instrument is described wherein water is made to rise and fall by the changes of temperature. The Spanish Saracens used a form of hydrometer to detect variations in temperature. See AREOMETER; HYDROMETER; THERMOMETER.

Heat expands the air, forcing down the liquid, and cold has the contrary effect. The temperature is thus indicated by the height of the liquid in the tube.

STURMIUS's differential air-thermometer consists of two bulbs united by a tube which is bent to form two legs, against one of which is attached a graduated scale. A quantity of sulphuric acid colored with carmine is introduced into the tube so that its upper surface corresponds with zero on the scale. The ball above the scale is termed the focal ball.

The amounts of air in the respective ends are so adjusted that when the bulbs are both exposed to the same temperature the liquid will fill one leg and the horizontal portion of the tube, the level of the graduated tube standing at zero. When both the bulbs are exposed to the same temperature no change takes place in the position of the liquid;

Fig. 117.



Differential Air-Thermometer.

but when the focal ball is exposed to heating or cooling causes, the air will expand or contract, and the column of liquid in the graduated leg will ascend or descend as the case may be. This thermometer is particularly adapted for ascertaining the particular degree of heat accumulated at a particular point, while the surrounding atmosphere is but little affected, as in the focus of a reflecting mirror, etc.

Leslie, in his experiments on heat, made great use of this differential thermometer. By coloring the focal ball and leaving the other white, silvering or gilding one of the balls, covering one with a moistened envelope, etc., he constituted the instrument a photometer, æthrioscope, hygrometer, etc.

Air is more equable in its expansion than mercury with equal increments of temperature.

The following shows the indications on the two scales at the same temperatures; correction being made for the expansion of the glass.

Air Thermometer.	Mercurial Thermometer.	Difference.
212.00°	212°	0.00°
299.66	302	2.33
386.69	392	5.31
473.09	482	8.91
558.86	572	13.14
662.00	680	18.00

In effect, however, the expansion of the glass is about equal to the increase of the rate of the expansion of the mercury, so that the mercurial glass thermometer is accurate as high as 662°.

For temperatures above the boiling-point of mercury, air-thermometers are used. Dry air, when confined, increases in volume $\frac{3}{8}$ for every 180°, and is believed to be perfectly equable in its rate of expansion.

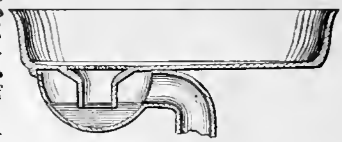
A bulb or cylinder with a tube of platinum is connected to a glass tube at right angles therewith. The glass tube is of uniform bore, is filled with mercury, and terminates below in a recurved bulb. The glass tube is divided into a number of spaces, each equivalent to $\frac{3}{8}$ of the total volume of the platinum bulb or cylinder, with $\frac{3}{4}$ of its stem. The other $\frac{1}{4}$ is supposed to be beyond the immediate influence of heat. The platinum bulb and $\frac{2}{3}$ of its stem are plunged in the furnace, and the depression of the mercury by the heated and expanded air within the instrument pressing on it more powerfully than the external air, will indicate the degree of temperature. Each degree of the glass stem is equal to 180° Fah.

Air′-trap. Sometimes called *stench-trap.* It is an adjunct to a vessel of any kind, such as a washbowl, water-closet bowl, urinal, or sink, which discharges by pipes or sewers up which a current of foul air is liable to pass.

Some of them are very simple in their character, and consist of a water-pan in which is submerged the end of the discharge-pipe of the bowl above. This shuts off the passage of air, and an overflow is afforded to the water as it reaches a certain height.

CRAIGIE's sink, July 2, 1867, is of this character, and its essential feature has been familiar to builders and housekeepers for many years. In the illustration the novel feature is found in the mode of attaching the trap-cup to the bowl and the discharge-pipe to the bend of the cup.

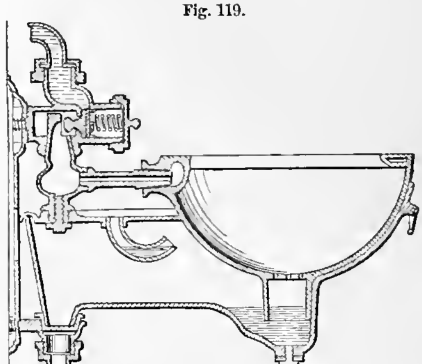
Fig. 118.



Craigie's Sink.

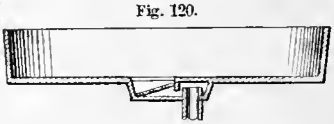
CARR, December 6, 1864. A spout, continuous from the bottom of the basin, descends into the water held in a depressed part of the receptacle. The flow of water into the upper part of the basin is regulated by a valve controlled by a cam movement. The drip from this flow, falling upon the top of this receptacle, is conducted by flanges to a descending tube, which is turned upward within the receptacle, so as to form an inverted siphon, and thus deliver its water into the receptacle without permitting the gas to ascend.

Fig. 119.



Carr's Urinal.

Fig. 120.

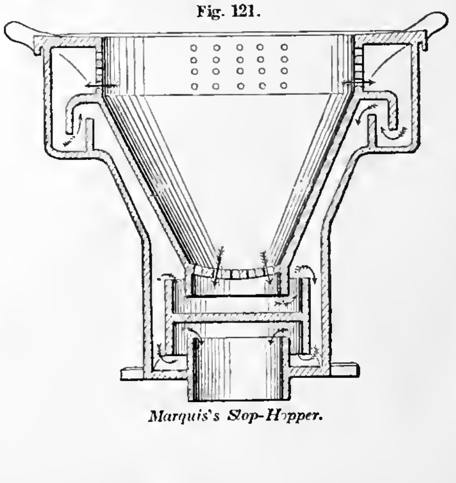


Carson's Sink.

CARSON, September 25, 1860. A perforated plate opposes the passage of matter likely to choke the pipe, which enters a chamber beneath the sink. The water passes to the chamber beneath a plate whose edge is submerged in liquid and forms a trap.

MARQUIS, September 4, 1866. A double trap is

Fig. 121.



Marquis's Slop-Hopper.

formed by compelling the water to pass by a sinuous course through a circular pan and then through an annular pan, on its way to the discharge-pipe.

Air′-trunk. A pipe or conduit for conducting foul or heated air from a room, theatre, or ward.

Air′-tube. A small, wrought-iron tube hung in a coal-box from the deck, and filled with water, for the purpose of ascertaining the temperature of the coals by a thermometer, as a precaution against spontaneous combustion.

Air′-tube for conveying Letters, Goods, and Passengers. This idea suggested by Dr. Papin about 1695, patented by Medhurst in England 1810, on the air-compression principle, and by Vallance in 1824 on the exhaust principle, has come into operation to some extent, and is considered under the head of PNEUMATIC TUBE (which see).

Air′-valve. (*Steam-Engine.*) A valve in a steam-boiler, which opens inwardly to allow air to enter when the internal pressure is below the atmospheric. This may be produced by the condensation of steam when the fire is drawn, and the device is to prevent collapse of the boiler.

Air′-ves′sel. An air-reservoir; it is applied to those air-chambers from which the air is to be drawn for use, as in carbureters, and one form of air-pump. See AIR-HOLDER.

A chamber on the ejection-pipe of a pump, to render the stream continuous. See AIR-CHAMBER.

Aisle. (*Arch.*) A side-division of a church, partially separated from the nave and choir by columns.

Aitch′-piece. (*Mining.*) The part of a plunger-lift in which the clacks are fixed.

A-jambe′. A French window with four casement windows, separately hinged and fastened.

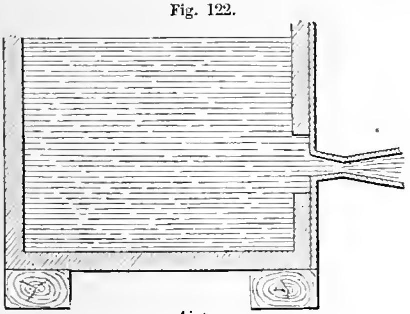
Aj′u-tage. 1. The spout or nozzle of a funnel.

2. A tube applied to the sides of a discharging orifice in a vessel, in order to obviate the resistance to the discharge incident to the contraction of the fluid vein. This resistance may amount to 0.45 of the whole theoretical delivery.

The addition of a cylindrical tube to the opening will cause a greater discharge, the head and sectional area remaining the same.

If the ajutage be cylindrical, and the water fill it entirely, the increase in the discharge, when the length of the ajutage does not exceed four times its diameter, is in the proportion of 1.33 to 1.00.

Fig. 122.



Ajutage.

The effective discharge may be still further increased by making the ajutage of the form represented by the accompanying figure, provided the liquid fill it entirely. This ajutage is composed of two portions of cones upon the same horizontal axis; the first has the form of the contracted vein, the length of the second is three times that of the first, and the opening into the tube from the chamber is $\frac{2}{3}$ of the size of the delivery opening. The effective discharge through an ajutage of this description is generally stated to be in the proportion of 3 to 2 of that which would take place through an orifice in a thin plate.

Venturi gives the following data: —

Orifice of delivery	0.0338 *m.*
Orifice of entry	0.0406 *m.*
Angle of sides of external tube .	5 6°

The length nine times the diameter of the effective opening.

He found the discharge to be increased to 1.46 times the theoretical discharge, and 2.4 times the discharge that would have taken place had the orifice been in a thin plate.

Al′a-bas′ter. 1. A species of marble, white or colored. Sometimes called Oriental alabaster, to distinguish it from

2. A granular, compact, semi-pellucid gypsum which is found in masses, white or colored, and is readily turned into vases and ornaments.

A-larm.′ An audible warning. Alarms, mechanically considered, are of many kinds; the purpose or construction of each is usually indicated by its name. They are placed in such positions or under such circumstances as to give warning of danger or to call attention.

Marine Alarms are fog-bells, whistles, and trumpets, operated by the tide, the waves, the current, the wind, or by clock-work.

Shoal Alarms are similarly actuated, being situated on spits or banks, anchored, moored, or attached to piles.

Nautical Alarms, on shipboard, are to indicate a leak or the accumulation of bilge-water.

Burglar Alarms are attached to doors or windows to give notice of surreptitious entrance by thieves.

Fire Alarms are actuated automatically by thermostatic arrangements, and give notice of fire, as their name indicates.

Clock Alarms are attached to timepieces to strike an alarm at a given hour.

Gas Alarms indicate an escape of gas, either in a room, or from the fissures in a coal-mine.

High-pressure Alarms are for indicating a dangerous pressure of steam in the boiler.

Low-water Alarms are for indicating the subsidence of the water-level in the boiler below the point of safety.

A *Pocket Alarm* is to notify a person of the abstraction of a book, etc. from the pocket.

Telegraphic Alarms are to call the attention of the operator to his instrument.

Till, *Trunk*, *Safe*, *Lock*, and *Door Alarms* are to call attention to the opening of the objects to which they are attached.

The *Watchman's Alarm* may be a rattle used by the police, or a systematic mode of communicating a signal of danger.

Funnel and *Barrel-filling Alarms* are to indicate that the vessel is nearly full.

A *Mill-hopper Alarm* is to indicate that the grist is about exhausted, and thus notify the miller that more grain is needed.

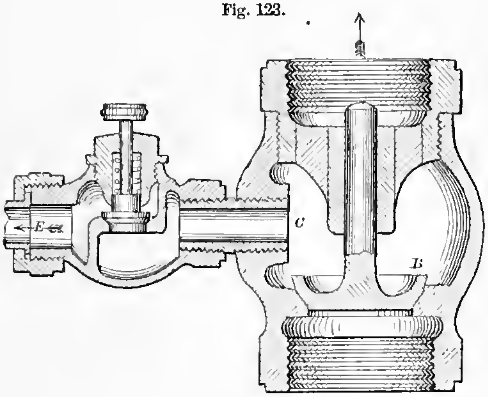
There are over two hundred patents in the United States for various forms of alarms.

See under the respective heads: —

Alarm check-valve.
Alarm-clock.
Alarm-funnel.
Alarm-lock.
Alarm-watch.
Annunciator.
Atmospheric alarm-whistle.
Bank alarm-telegraph.
Bilge-water alarm.
Burglar alarm.
Clack.
Clack-mill alarm.
Clock alarm.
Door alarm.

Earthquake alarm.	Nautical alarm.
Electric alarm.	Pocket alarm.
Electric annunciator.	Safe alarm.
Fire alarm.	Shoal alarm.
Fire-damp alarm.	Steam-boiler alarm.
Fog alarm.	Steam-whistle alarm.
Gas alarm.	Telegraphic alarm.
High-pressure alarm.	Temperature alarm.
Iceberg alarm.	Thermometric alarm.
Leak alarm.	Tide alarm.
Low-water alarm.	Till alarm.
Marine alarm.	Trunk alarm.
Mill-hopper alarm.	Watch. Alarm
Money-drawer alarm.	Watchman's alarm.

Fig. 123.



Alarm Check-Valve.

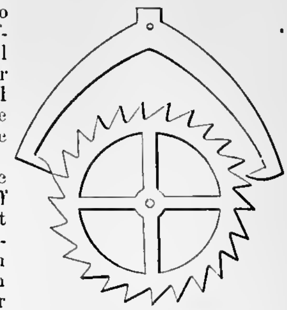
A-larm' Check-valve. (SELLER'S IMPROVED.) (*Steam.*) A valve to notify the engineer whenever the injector ceases to operate or fails to start.

If the injector is not working into the boiler when the escape-valve is closed, the steam will back up in *C*, and tend to pass out into the water supply and tank. As soon, however, as any pressure occurs in the upper part of the supply-pipe, the check-valve *B* will close, and the steam then exerts its pressure on the small check in the lateral pipe *C E*, which leads to the waste-pipe. This small valve, which is kept in its seat by a spiral spring, as shown in the drawing, will then be raised, and allow the steam to escape into the waste-pipe in a way that cannot fail to secure notice.

A-larm'-clock. From a work published in 1661, we find that "Andrew Alciat of France had a kind of clock in his chamber that should awaken him at any hour of the night that he determined, and when it struck the determined hour, it struck fire likewise out of a flint, which fell among tinder, to light him a candle; it was the invention of one Caravagio of Sienna in Italy." The Marquis of Worcester, 1655, suggests that the tinder-box may form a serviceable pistol. This is anticipating some of the *burglar alarms* of our own time.

The clock alarm consists of a bell or wire coil and a hammer which is set in motion by an arrangement substantially similar to the recoil escapement in the attached cut. A weighted cord or spring, being wound on the axis of the scape-wheel, rotates it as soon as it is free to move. If we suppose a short hammer instead of a long pendulum attached to the axis of the pallets, and the wheel to be driven with sufficient force, it will oscillate the hammer and cause the head to strike on alternate sides of the bell inside which it vibrates.

Fig. 124.

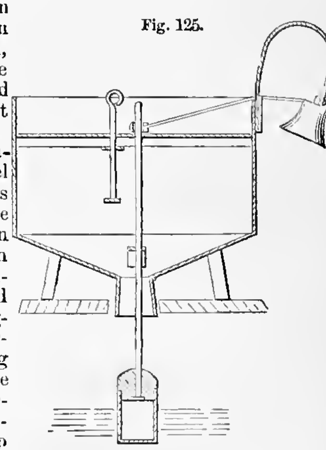


Recoil Escapement.

If the alarm were always to be let off at the same time it would only be necessary to set a pin in the proper place in the twelve-hour wheel to raise the lifting-piece which lets off the alarm at that time. To make it capable of adjustment, the discharging pin is set in another wheel (without teeth), which rides with a friction spring upon the socket of the twelve-hour wheel, and has a small movable dial attached to it, with figures so arranged in reference to the pin, that, whatever figure is made to come to a small pointer set as a tail to the hour-hand, the alarm shall be let off at that hour. The letting off does not require the same apparatus as the striking movement, because it is not to strike a definite number of blows, but to go till it is run down.

The lifting-piece is nothing but a lever with a stop or hook upon it, which, when it is dropped, takes hold of the alarm-wheel, and disengages it when raised.

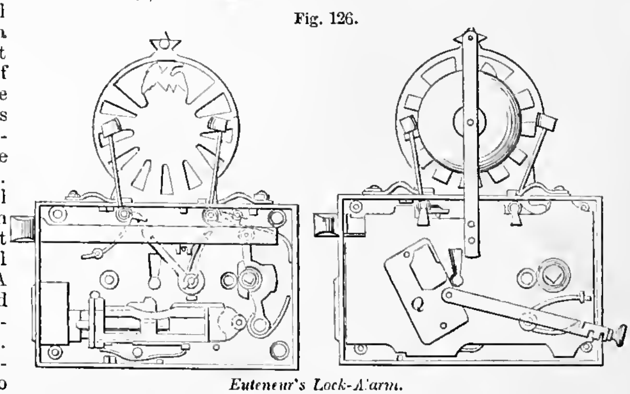
Fig. 125.



Alarm Funnel.

A-larm'-fun-nel. A funnel which indicates that liquid in the barrel has risen to a certain point. The funnel being placed over the bung-hole of the barrel, the rising liquid raises the float, which detaches the button from its stop and rings the alarm-bell.

Fig. 126.



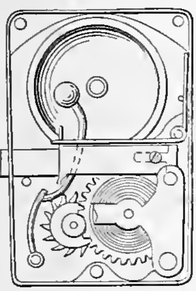
Euteneur's Lock-Alarm.

A-larm'-lock. In the Marquis of Worcester's "Century of Inventions," No. 72, A.D. 1655, a lock is referred to which, if tampered with by a stranger, will start an alarm beyond the control of the intruder. As usual, the thing is merely hinted at, the purpose of that Digest of Inventions being more to act as a reminder to the inventor than as a specification for another reader.

EUTENEUR, September 19, 1865, (Fig. 126,) has an arrangement of devices by means of which any movement of the latch-bolt causes two hammers to strike a bell. A plate covers the key-hole to prevent the admission of a key from the outside; the plate is held closed by a bar attached thereto and projecting through the case. The two hammers are so pivoted as to be tripped by the motion of the latch-bolt, striking the bell on the recoil.

DECROW, December 12, 1865. The device consists of a bell, hammer, escapement, and a spring. The bolt is so arranged as to trip the escape-wheel, when moved in either a vertical or a horizontal direction, and release the hammer, which is oscillated rapidly to give a quick succession of strokes upon the bell.

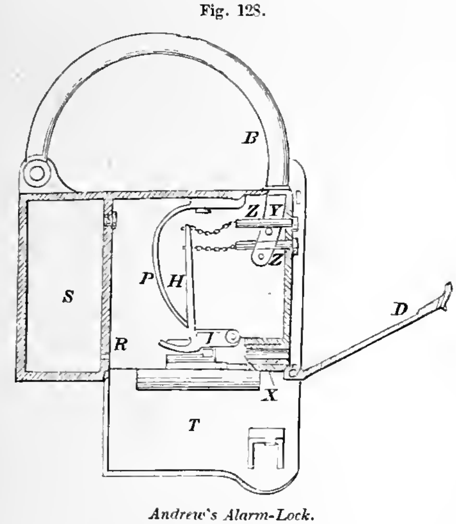
Fig. 127.



Decrow's Alarm.

A padlock with an alarm attachment is shown in Fig. 128. The shackle *B* is fastened by screws *Z Z*, whose heads are exposed. They are connected by chains to the arm *H* of a trigger *I*. The barrel *X* is moved by the spring *P*, a cap is exploded, a ball projected, and fire communicated through the opening *R* into the magazine *S*. *D* is a cover for the screw-heads *Z*. *T* is the fallen face-plate of the lock-case.

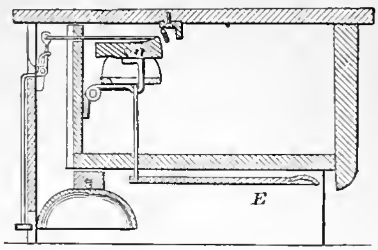
Fig. 128.



Andrew's Alarm-Lock.

A-larm'-lock for Tills. Alarm-locks are attached to tills so as to ring when the drawer is pulled open. The devices are numerous. In Fig. 129 is shown one in which the contact of the head *a* with a detent beneath the counter causes the said head to vibrate and swing the hammer-rod which

Fig. 129.



Tucker's Alarm-Till.

sounds the gong. By raising the trigger *E* the drawer may be opened silently.

A-larm'-watch. An instrument, not necessarily a timepiece, with going works, and adapted to run down and sound an alarm after a specific interval of time. See WATCH ALARM.

Al-ba'ta. German silver, composed of nickel, copper, and zinc; with the addition of small quantities of lead or iron in some formulas.

It is a white alloy, used for table-ware, etc., and resembles the Chinese Packfong, or white copper.

The following are some of the formulas: —

Common, Nickel, 4;	Copper, 20;	Zinc, 16.		
Better, " 6;	" 20;	" 10.		
For rolling, " 25;	" 20;	" 60.		
For casting, " 20;	" 20;	" 60;	Lead, 20.	
Packfong, " 31.6;	" 40.4;	" 25.4;	Iron, 2.6.	

See ALLOY.

Al'ber-type. (*Photogr.*) The process is as follows: "A plate of glass is covered with a solution of albumen, gelatine, and bichromate of potash, dried and exposed to light until hardened. It is then again covered with a solution of gelatine and bichromate of potash, and when dry exposed under the negative, and the film is then found to possess qualities analogous to a drawing made with fatty ink upon lithograph stone. All those portions of the film that were acted upon by the light will refuse water and take printing-ink, while those portions which were protected from light by the negative will take water and refuse ink. The ink and water will be absorbed by the film just in accordance with the gradations of light and shade in the negative. To produce a picture, wet the surface of the film, then apply ink, lay on paper, and pass through a press; the operation being substantially the same as lithography. The process is said to be rapid, and excellent pictures of all sizes may be printed in admirable style."—*Photographic News.*

Al'bo-lite Cement. Invented by Riemann. Mix calcined and finely pulverized magnesite (native carbonate of magnesia) with infusorial earth, and stir in chloride of magnesium. Among the properties of the cement, as enumerated by the inventor, are a high degree of plasticity, and of hardness after it has become fixed, and a spontaneous development of heat as soon as it is solidified to the consistency of wax, this increasing in proportion to the size of the mass into which it has been molded. It is extremely hard, a peculiarity increased by its elasticity, and adheres very well to stone, wood, and dry oiled surfaces, but cannot be used under water. It is now largely employed in the preparation of ornamental moldings, for which, however, in consequence of the above-mentioned development of heat, gelatine molds must be cautiously used. By coating ornaments of gypsum with this cement it imparts to them a great degree of hardness. It is also used for repairing worn-down sandstone steps, for facing stone and wooden steps, for fire-proof coating to boards in the interior of houses, and also for preserving railroad-ties, etc.

Al′bum. A book arranged to hold photographs, autographs, or memorial addresses of a private character.

The principal concern of the mechanic arts with the album is with devices for sewing the leaves in the book, making the slip-pockets for the reception of cards, clasps, and securing devices for the leaves of the cover.

The *album* was originally the tablet on which the Roman prætor's edict was written. It was *white*, and hung up as a bulletin-board in a public place.

It is now a book of friendly memorials: signatures, prose or poetic effusions, or photographs. It dates back to the church blank-book, or *white*-page book, in which were inscribed the names of benefactors of the church, in order that the appointed prayers might be made as the feast-days of their chosen saints recurred.

The Venerable Bede, in his preface to the Life of St. Cuthbert, A. D. 721, speaks of the record of the saint's name in the *album* at Lindisfarne. The name frequently occurs in ecclesiastical and other writings.

Al′bu-men Process in Photography. This process antedated the collodion, which is much more sensitive. It was invented by Niepce de St. Martin. The glass receives a coating from a solution of albumen to which bromide and iodide of potassium and a drop of caustic potash have been added, and after drying is exposed to the fumes of iodine. It is then silvered in a bath of nitro-acetate of silver, and dried. After passing again over the vapor of iodine it is ready for the camera. The image is developed by a solution of gallic acid, and fixed by a solution of hyposulphite of soda. — *Mayall.*

Al′car-ra′za. A vessel of porous earthenware used for cooling the contained liquids by evaporation from the exterior surface. See ICE-MACHINE. The word is Arabic, and the device was introduced into Europe by the Spanish Saracens.

Alcarrazas are made of a sandy marl made up into paste with saline water and lightly fired.

"In niches where the current of air could be artificially directed hung dripping alcarrazas." — *Description of the Alhambra.*

Al′co-hol En′gine. An engine in which the vapor of alcohol is used as a motive-power.

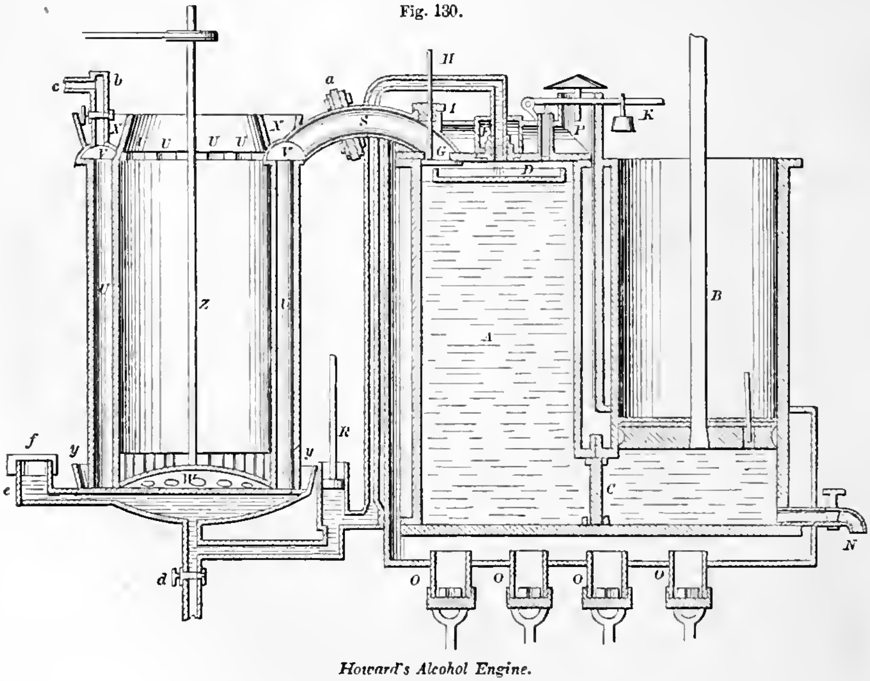
The first suggestion of the machine was by Rev. Edmund Cartwright at the latter end of the last century. The reason why the elastic vapor of alcohol was supposed to be preferable to that produced from water is that it boils at a temperature considerably below that of water. It must be recollected, however, that all leakage and escape of alcohol is not alone an absolute loss of a valuable material, but that such leakage is very dangerous, owing to the inflammability of the material.

HOWARD'S alcohol engine, English patent, 1825, was in use at the Rotherhithe Iron-Works for some time, but appears to have wearied out the patience or means of the inventor, no engine of that description being now usefully employed so far as we are aware. The engine referred to was intended to work up to 24 horse-power.

The engine had two vertical cylinders *A B*, of equal capacity, connected by a pipe *C*, at the lower part of each. A quantity of mercury or oil, which will not vaporize at the heat to be applied, is placed in each cylinder, so as to fill the base of one and nearly the whole of the other.

Within the cylinder *B* is a piston, exposed above to the pressure of the atmosphere, and packed in the cylinder in the usual manner. In the other cylinder *A* is a thin metallic dish *D*, floating freely upon the surface of the oil. A tube *E*, terminating in a nozzle pierced with small holes, passes through a stuffing-box in the cover of the cylinder *A*, in which also is a flap-valve *G* opened by a rod *H* as

Fig. 130.



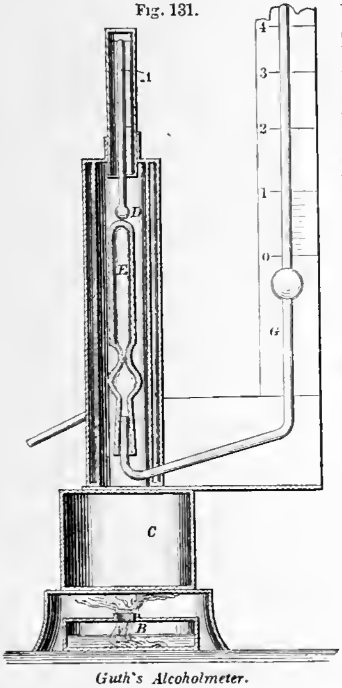
Howard's Alcohol Engine.

occasion requires. The valve is otherwise kept to its seat by a spring. I is the stuffing-box of the valve-rod; K the safety-valve. The piston has a plug by which a certain quantity of the fluid is admitted above its upper surface, there to remain. N is a discharge-cock. o o are argand-burners, which heat the cylinders A B by direct action upon their lower surfaces, the hot-air flue extending around them and terminating in the chimney P, which has a register-cap a by which the draft is regulated.

By means of a force-pump R, worked by the engine, a small quantity of alcohol is drawn from the condenser and injected through the pipe E into the dish D, which floats upon the hot oil in the cylinder A, and is thereby flashed into steam. The expansion of the alcohol depresses the column of oil in the cylinder A, driving it through the passage C into the cylinder B, where it raises the piston.

When the piston has attained its highest elevation, the valve G is opened and the vapor escapes by pipe S to the condenser, which consists of an upper and lower chamber connected by pipes V V. These pipes are surrounded by flannel constantly wetted by water dripping from the trough X, and the evaporation is expedited by a continued draft of air from the rotating fly Z, which is driven by the engine. Y is the lower trough, which receives the superfluous water, and W is the bottom chamber, which contains the condensed vapor and from which it is drawn by pump R to produce each upward movement of the piston. A cork or wooden packing in the connecting-pipe S prevents the conduction of heat from one part of the apparatus to the other. The condensation of the alcoholic vapor causes the return of the oil into the cylinder A, and the atmospheric pressure causes the piston to descend. c, b, are the pipe and stop-cock by which the atmospheric contents of the condenser are withdrawn, previous to starting the engine. d is the discharge-pipe by which the condenser may be drawn from the chamber W. f is the pipe at which the chamber W is charged with alcohol. It is closed by a screw-pipe when the machine is in action.

Fig. 131.

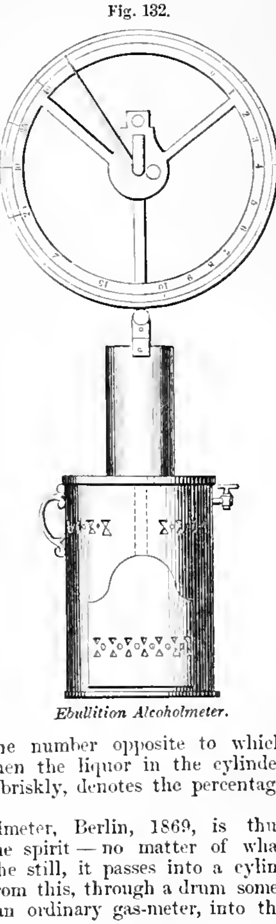


Guth's Alcoholmeter.

Al'co-hol'-me-ter. A modification of the hydrometer, for the purpose of ascertaining the comparative specific gravity and consequent amount of alcohol in spirituous liquors, etc. This instrument may either be so constructed as to be sunk, by weights, to a uniform depth in the liquor tested, or it may indicate the gravity by the amount of its submergence, as shown on a graduated stem, taking either pure alcohol or "proof" as a standard; the latter mode of construction is more convenient in practice, and more generally adopted. The absolute percentage of alcohol, or the degree above or below proof, is deduced from tables constructed for that purpose and corresponding to various temperatures of the liquid.

GUTH, June 28, 1859. In this alcoholmeter the evaporation of a fixed quantity of alcoholic fluid is made to exhibit the exact percentage of alcohol contained in the said liquid. While the tube E is yet detached from the apparatus, it is partially filled with mercury, and then receives a definite amount of the alcoholic liquid to be tested. When inverted and placed in position in the instrument the liquid and mercury change places, the former occupying the upper part of chamber E. Heat being applied, by means of the spirit-lamp B, to the water in chamber C, the vapor rising therefrom, filling chamber D, heats the mercury and the alcoholic liquid, the temperature being indicated by the thermometer A. As alcoholic vapor is eliminated from the liquid it presses upon the column of mercury, causing it to rise in the stem G, and the height of the column against the graduated scale indicates the amount of spirit.

Fig. 132.



Ebullition Alcoholmeter.

The ebullition alcoholmeter of VIDAL is founded upon his discovery that the boiling temperature of alcoholic liquors is proportional to the quantity of alcohol contained in them. It consists of a spirit-lamp, beneath a small boiler, into which a large cylindrical glass bulb is plunged, having an upright stem of such caliber that the quicksilver contained in them may, by its expansion and ascent when heated, raise before it a little glass float in the stem, which is connected by a thread with a similar glass bead that hangs in the air. The thread passes round a pulley, which, turning with the motion of the beads, causes the index to move along the graduated circular scale.

The numbers on this scale represent percentages of absolute alcohol; so the number opposite to which the index stops, when the liquor in the cylinder over the lamp boils briskly, denotes the percentage of alcohol in it.

SIEMEN'S alcoholmeter, Berlin, 1869, is thus described: "As the spirit — no matter of what strength — leaves the still, it passes into a cylindrical vessel, and from this, through a drum something like that of an ordinary gas-meter, into the cask which is to contain it. On its way through the apparatus it is measured, gaged, and registered with the greatest possible exactness. First, its bulk or volume is measured and indicated in gallons and decimal parts; and, second, the quantity of either absolute alcohol or of proof-spirit which it contains is measured and indicated independently. The measurement and registration of the total bulk or quantity of spirit which passes over is obviously done directly by the rotation of the drum, each of the three divisions of which holds exactly five gallons. The indication of the strength of the spirit is done by a swimmer in the cylindrical vessel into which the alcohol first enters as it leaves the still. This swimmer is attached to a pointer, which, in being elevated and depressed by the lowering or rising of the swimmer, according to the varying specific gravity of the liquid, limits the reciprocating movements of a graduated tongue in connection with the counter-work. Thus, not only do the distiller and the exciseman know at a glance how much spirit in total has been distilled within a given time, but likewise how much proof-spirit it is equivalent to. —*Engineer.*

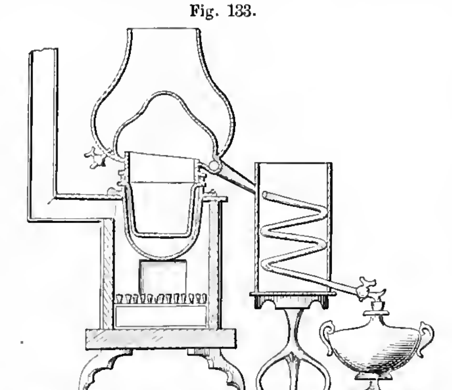
See also LIQUID-METER.

Al′cove. (*Architecture.*) A recess separated from a main chamber by columns, antæ, and balusters.

A recess in a room for a bed or for seats.

A-lem′bic. The head or cap which is placed upon the cucurbit, and which discharges by its beak into the receiver. The cucurbit contains the liquid to be distilled, and the alembic is luted thereto to

Fig. 133.



Alembic.

prevent the escape of vapor which is raised by the heat of the fire, and is conducted to the receiver to be condensed. Some alembics have an aperture in the head to admit material to the retort when the stopper is temporarily removed.

We are indebted to the Arabs for this apparatus and its name. Zozimus, who flourished about A. D. 400, described the operation of purifying water by distillation.

Djafar, the great Arabian chemist, about A. D. 875 discovered nitric acid, which he obtained by the distillation in a retort of Cyprus vitriol, alum, and saltpeter. He obtained aqua-regia by the addition of sal-ammoniac, and no doubt felt that in obtaining a solvent of gold he had discovered the long-desired *aurum potabile*.

Rhazes, the Arabian, born 860, obtained absolute alcohol by distilling spirits of wine with quicklime.

Achild Bechil, of the same people, distilled together an extract of urine, clay, lime, and powdered charcoal, and obtained phosphorus.

A *blind-alembic* is one having a capital with no rostrum.

A-len′çon Lace. Also called *blonde*. A variety of lace formed of two threads, twisted and worked to a hexagonal mesh.

Alençon point is formed of two threads to a pillar, with octagonal and square meshes alternately.

Al′eu-rom′e-ter. The name given to an instrument invented about 1849, by M. Boland, a Parisian baker, for determining the quality of the gluten in different specimens of wheaten flour, and their consequent adaptation for bread-making. A tube of about six inches in length is divided into two parts, of which the smaller one, about two inches in length and holding a given amount of gluten, is screwed on to the longer tube, which is fitted with a piston having a graduated stem. The apparatus is then exposed to a moderate degree of heat, when the gluten expands, forcing up the piston, the amount of expansion being indicated by the distance the stem protrudes from the tube. It was found that gluten obtained from flour of good quality would expand to four or five times its original bulk, and had the smell of warm bread, while that of bad flour became viscid, with a tendency to adhere to the tube, and in some instances emitting an unpleasant odor.

Al′i-dade. (*Optical Instr.*) The movable arm of a graduated instrument carrying sights or a telescope, by which an angle is measured from a base line observed through the stationary or level line of sights.

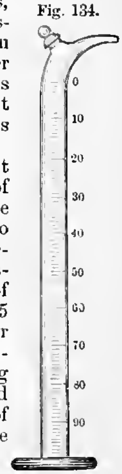
Used in theodolites, astrolabes, demicircles, and numerous other angulometers.

A-lign′ment. (*Engineering.*) The ground plan of a road or earthwork.

Al′ka-lim′e-ter. The object of this instrument is to ascertain the value of the alkalies of commerce. It was invented by Dr. Ure, about 1816, or by Mr. Descroizelles, and consists essentially of a graduated tube closed at one end, each graduation corresponding to a sufficient quantity of sulphuric or other acid to neutralize a given amount of pure soda or potash dissolved in water. The strength of the alkali is inferred from the amount of acid required to neutralize it.

The instrument recommended by Dr. Faraday consists of a burette supported upon a foot and graduated into one hundred equal parts, the space between each two of the divisions being capable of containing ten grains of distilled water. The upper part of the instrument is shaped, as shown in the figure, for the convenient introduction of the test acid and its subsequent delivery in drops.

Fig. 134.



Alkalimeter.

To employ it for estimating the amount of carbonate of potash in any sample of pearlash, weigh out 100 grains of the ash, dissolve them in boiling water, so that, when cool, the mixture has a specific gravity of 1.1268. Filter if necessary, and tinge blue with infusion of litmus; then fill the alkalimeter to 65 with the test acid, diluting with water to 0°, and add the diluted acid gradually and cautiously until the reddening effect is produced upon the dissolved sample. The number of measures of acid required represents the percentage of carbonate of potash in the sample.

To estimate the amount of potash contained in the sample, either as caustic potash or carbonate of potash, fill the alkalimeter to

49 with the test acid, the 100 measures being again made up with water. The number of divisions of this dilute acid required to neutralize 100 grains of the sample will correspond to the proportion of pure potash in the sample.

For the determination of carbonate of soda, the alkalimeter must be filled to 54.6 with the test acid, which must then be used as before. For the estimation of caustic soda, the operator will require to fill the instrument to 23.4. The number of measures required to change the blue of the solution to red will in both cases correspond to the percentages of caustic or carbonated alkali required.

All-a-long′. A bookbinder's term to denote that the sewing-thread passes from end to end of the fold, or directly between the distant points of puncturation.

Al′lege. (*Fr.*) A ballast-boat.

Al-lette′. (*Architecture.*) A wing of a building; a buttress or pilaster.

Al′ley. (*Printing.*) The compositor's standing-place between two opposite frames.

Al-loy′. An alloy is a combination by fusion of two or more metals, as brass and zinc, tin and lead, silver and copper, etc.

Many alloys are composed of definite chemical proportions of their component metals, whilst in others the metals unite in any proportions.

The best-known and perhaps the most generally useful alloy is brass, which is formed by the fusion together of copper and zinc.

The Colossus at Rhodes was said to have been constructed of brass B. C. 288. Bronze is a much more ancient alloy than brass, and has been known from a very remote antiquity. See BRASS and BRONZE. All alloys are opaque, have a metallic luster, are more or less elastic, ductile, and malleable, and are good conductors of heat and electricity. Those consisting of metals of very different degrees of fusibility are usually malleable when cold and brittle when hot. Metallic compounds containing mercury are *amalgams*. Metals do not unite indifferently with each other, but have certain affinities; thus silver, which will hardly unite with iron, combines readily with gold, copper, or lead. Alloys are generally harder and less ductile than the mean of their constituents, and their specific gravity is usually either greater or less than this mean. (See Table.) The melting-point of alloys is usually below that of either of the simple metals composing them; thus, an alloy of 8 parts bismuth, 5 lead, and 3 tin, fuses at the heat of boiling water, or 212°. See FUSIBLE ALLOYS.

They very frequently possess more tenacity than their constituents would seem to indicate; thus an alloy of 12 parts lead and 1 part zinc has double the tenacity of the latter metal, or about six times that of lead.

They are, in general, more easily oxidized than their component metals. An alloy of tin and lead unites with oxygen so readily as to take fire and burn when heated to redness.

A very slight modification of the components often produces a great change in the mechanical properties; brass, containing two or three per cent of lead, is most readily turned, but works badly under the hammer, while that of the best quality for hammering is not turned with facility, owing to its toughness.

The precious metals, when employed for coin or jewelry, are invariably alloyed to increase their hardness; the degree of fineness, or proportion of pure metal, being usually estimated in carats or twenty-fourths. In this case the term "alloy" is often understood to apply merely to the baser metal with which the gold or silver is combined. Thus the British standard for gold is 22 parts pure gold and 2 parts alloy, or 22 carats fine; for silver, 222 parts pure silver and 18 parts alloy.

The alloy for gold is an indefinite proportion of silver and copper; that for silver is always copper. The standard for silver plate is the same as for coin; that for jeweler's gold is 18 carats, but for some purposes the fineness is reduced to 12 and even 9 carats; silver is used for the alloy, and copper may be added to heighten the color.

Silver and palladium unite in any proportions, and it has been found that this alloy is not so readily tarnished as silver; it has been used for the graduated scales of mathematical instruments. Platinum has been used with silver for similar purposes, but requires greater care in fusion to make the combination.

Steel is much improved for cutlery by being alloyed with about $\frac{1}{100}$ part of silver; it is also improved by $\frac{1}{500}$ part of platinum.

From one to two per cent of rhodium has also been combined with steel, with excellent results.

BRASSES AND BRONZES WITH THE ADDITION OF IRON.

	Copper.	Tin.	Zinc.	Iron.	Lead.	Nickel.	Silver.
Ancient Bronze Sword, Ireland	83.50	5 15		3.0	8.35		
Ancient Bronze Sword, Thames, England	89.69	9.58		0.33			
Ancient Bronze Axe-head, Ireland	89.33	9.19		0.33			
Ancient Bronze Wedge, Ireland	94.	5.9		0.1			
Ancient Bronze Knife, Amaro, South America	95.66	3.96		0.37			
Coin of Hadrian	85.67	1.14	10.85	.74	1.73		
" " Tacitus	91.46			2.31			
" " Probus	90.68	2.00	1.39	.61	2.33		2 29
" " "	94.65	.45		.80	.45		3 22
" " Pompey	74.17	8.47		.29	16.65		
Chinese White Copper (Packfong)	40.4		25.4	2.6		31.6	
Keirs Metal, English Patent, Dec. 10, 1779	100.		75.	10.			
							Glass.
Keirs Metal, English Patent (another formula)	100.		80.	10.			40.
Tractable Yellow Metal (old formula)	55.33		41.8	4.06			
Fontainemoreau's English Patent, 1838	8.		90.	1.			
Cutler's English Patent, 1838	16.		5.	3.		.5	
Sorel's White Brass, 1840	10.		80.	10.			
Parke's English Patent, 1844	91.		21.	45.5		45.5	
Parke's English Patent (anotner formula)	4.5	128.	67.	2.5			
Parke's English Patent (another formula)	3.	48.	50.	1.			
Stirling's Gun-Metal, English Patent, 1846	50.		25.	1–8			
							Mang.
Stirling's "British Gold," English Patent, 1846	400.		93.	7.			6.
Bell-Metal (Overman)	71.	26.	2.	1.			
Aich's Metal, English Patent, Feb. 3, 1860	60.		38.125	1.5			
Rosthorn's Gun-Metal, Austria, 1861	55.04	0 83	42.36	1.77			
Rosthorn's Gun-Metal (another analysis)	57.63	0.15	40 22	1.86			
Navy Brass, Austria	60.		38.12	1.8			
Parisian Clock Bells	72.	26.5		1.5			
Birkholz Metal, United States Patent, Mar. 11, 1862	60.		38.	2.			

An English work of 1853 cites the addition of one to two per cent of iron to brass to give strength and sonorousness; and further states that "large guns, large screws, propeller-vanes, mill-brasses, railway-bearings, bells, and other articles are made of a metal in which copper, zinc, tin, and iron, all take part."

(*Brass.*) The alloys of copper and zinc retain their malleability and ductility when the zinc is not above thirty-three to forty per cent of the alloy. When the zinc is in excess of this a crystalline character begins to prevail. An alloy of 1 copper, 2 zinc, may be crumbled in a mortar when cold.

Yellow brass, that files and turns well, may consist of copper 32, zinc 9 to 18. A greater proportion of zinc makes it harder and less tractable; with less zinc, it is more tenacious and hangs to the file like copper.

Yellow brass (copper 2, zinc 1) is hardened by the addition of two to three per cent of tin, or made more malleable by the same proportion of lead. The tin whitens it; the lead reddens it. See Brass.

(*Bronze.*) A compound of copper and tin. The addition of tin increases the fusibility of copper. The red color is not materially affected by the addition of 5 parts tin to 32 copper, which makes engineer's brasses; it is considerably whitened when 32 copper is alloyed with 12 tin, this being the limit of bell-metal; and is quite white when 32 copper, 16 tin, is reached, this being speculum metal. When it has ceased to serve for producing sound it is used for reflecting light.

A small addition of zinc to a bronze alloy assists in the mixing, and increases the malleability without materially affecting the hardness. Lead increases the ductility of gun-metal, at the expense of its hardness and color. Mr. Donkin proposes the addition of nickel. Dr. Ure suggests antimony. The addition of from two to four per cent of iron to the gun-metal is claimed to make an extremely tough alloy. See Gun-metal; Bronze.

Sir J. Gardiner Wilkinson mentions finding a bronze chisel among the chippings of the limestone rocks in the neighborhood of Thebes, where it had been accidentally left by the workmen in ancient times. It is 9¼ inches in length, diameter at the summit 1 inch, and weighs 1 lb. 12 oz.

FUSIBLE ALLOYS (*Composition of*).

	Type-metal.	Lead.	Tin.	Bismuth.	Cadmium.	Melting-point.
Rose's		1	1	2		201° F.
Newton's		5	3	8		212
Newton's (another formula)		3	2	5		199
French	1	5	4	8		
Wood's			1	3	1	210
Wood's		6		7	1	180
Wood's Patent (March 20, 1860)		4	2	7 - 8	1 - 2	150 - 160
Wood's Patent for filling teeth (Sept. 4, 1864)		1 - 2	2 - 3	3 - 4	1 - 2	

KUPFFER'S TABLE OF FUSIBLE ALLOYS, — ATOMIC PROPORTIONS.

Lead.	Tin.	Melting-point.
1	5	381 ° F.
1	4	372
1	3	367
1	2	385
1	1	466
3	1	552

Holtzapffel's list is as follows: —

Tin.	Lead.	Bismuth.	Mercury.	Melting-point
1	25	...	...	558 ° F.
1	10	...	...	541
1	5	...	...	511
1	3	...	...	482
1	2	...	..	441
1	1	...	...	370
1½	1	..	...	334
2	1	...	...	340
3	1	...	...	356
4	1	...	...	365
5	1	...	...	378
6	1	...	...	381
4	4	1	...	320
3	3	1	...	310
2	2	1	...	292
1	1	1	...	254
1	2	2	...	236
5	3	3	...	202
5	3	3	3	122

According to a table arranged by Professor P. H. Vander Weyde, the fusion points of the undermentioned alloys are as follows: —

Bismuth.	Tin.	Lead.	Mercury.	Melting-point.
5	2	3	1	167 ° F.
4	...	1	⅓	185
4	1	1	...	203
5	4	1	...	257
1	...	1	...	284
...	3	2	...	329
...	3	1	...	338
Pure tin				428
Pure bismuth				500
Pure lead				617

A more extended table of the fusible points of the ordinary triple alloys is given in the *Bulletin de la Société Chimique*: —

Lead	Tin.	Bismuth.	Point of Fusion.	Point of Solidification.
120	140	120	130 ° C.	112 ° C.
145	145	100	140	129
150	150	75	150	135
150	150	50	160	150
170	180	35	170	163
210	190	30	180	165
140	155	30	190	180
200	185	30	200	180
200	180	30	210	180
240	150	30	220	180
207	194	30	180	180

The Egyptians soldered with lead as long ago as the time of Thothmes, B. C. 1490, the time of Moses. Pliny refers to the art, and says it requires the addition of tin for use as a solder. The tin came mainly from the Cassiterides (Cornwall).

Gold Alloys.

	Gold.	Silver.	Copper.
18-carat gold of yellow tint	360	66	54
18-carat gold of red tint	360	42	78
16-carat gold	36	6	12
16-carat gold nearly (yellow tint)	20	7	5
16-carat gold nearly (red tint)	20	2	8
11-carat gold nearly	20	11	11

Gold solders are made from gold of the quality of the article, say 18 or 16 carats, to which is added

$\frac{1}{12}$ of silver and one $\frac{1}{24}$ of copper; or a larger proportion of silver and copper for ware of inferior fineness.

JEWELER'S ALLOYS.

	Brass.	Copper.	Tin.	Zinc.	Silver.	Platinum.	Arsenic.	Antimony.	Glass.
Blanched Copper (Mock Silver)		16					1		
Imitation Gold (Hermstadt's); (this resembles gold in color and specific gravity)		7		1		16			
Semilor		5		1					
Manheim Gold		4		1	}				
or		3	¼	1	}				
Mosaic Gold (Hamilton and Parker's Patent)		32		33					
Pinchbeck		5		2					
Mock Platinum	8			5					
Bath Metal	32			9					
Very hard Bronze (Chantrey's)		32	5	5					
Speculum Metal		7	4	3					
" "		6	2				1		
" "			1					1	
Martin's Patent, Aug. 23, 1859		100		18¾	16				$\frac{10}{16}$
Or Molu		48		52					
Tombac (Malay, tambaga, copper)		16	1	1	Lead.	Nickel.			
Red Tombac		11		1					
Mock Silver (Toucas's Patent, 1856, England)		5	1	1	1	4		1	

Mock Gold (Hackert's, patented June 11, 1867), cream of tartar, 8 oz.; saltpeter, 1 oz; melt, and add melted copper, 8 oz.; borax, 1 oz.; zinc, 1 oz.; tutty, 1 oz.

SOLDERS (*Composition of*).

	Gold.	Silver.	Copper.	Tin.	Zinc.	Lead.	Bismuth.	Brass	Melting-point.
Pewterer's				2		1			360°
Pewterer's, soft				3		4	2		
" "				2		1	1		
Tinman's				1		1			393
Coarse				1		3			500
Plumbers'				1		2			475
Hard Spelter			16		12				1869
Gold *	12	2	4						
For Brazing Steel		19	1					2	
Hardest Silver		4	1						
Hard Silver		3						1	
Soft Silver		2						1	
For Aluminium (Starr's, Mar. 10, 1858)		2		2	1	2			

* Various proportions are employed, according to the fineness of the article, so as not to risk the test of assay.

TYPE-METAL (*Composition of*).

	Lead.	Antimony.	Tin.	Nickel.	Cobalt.	Copper.	Bismuth.	Cadmium.
For the smallest and most brittle types	3	1						
For those a grade softer	4	1						
" medium sized types	5	1						
" large types	6	1						
" largest and softest types	7	1						
" stereotype plates	4–8	1						
" " " new recipe	500		300					225
Bealey's patent type-metal (1855, England)	100	30	20	8	5	8	2	

From four to six per cent of tin is used in the smaller types, and sometimes a small amount of copper.

In this alloy the antimony fulfils another service besides imparting hardness. Antimony expands somewhat in cooling, whereas lead contracts considerably; the antimony therefore, within certain limits, compensates for the contraction, causing the alloy to retain the full size of the mold, making the letters sharp.

Sometimes, from motives of economy, the neighboring parts of machinery are not wrought accurately to correspond one with the other, but metal is poured in to fill up the intermediate space and make contact. Antimony is an essential addition in such cases to prevent the contraction the lead alone would sustain, and which would defeat the intended object, as the metal would otherwise become smaller than the space to be filled.

WHITE METAL ALLOYS.

	Copper.	Tin.	Zinc.	Lead.	Antimony.	Arsenic.	Bismuth.	Nickel.	Brass.
Speculum Metal		1			1				
" "	6	2				1			
" "	7	4	3						
Pewter	6	112	2	16					
"		4		1					
Hard Pewter	4	192			16				
Best Pewter		100			17				
Pewterer's "Temper"	1	2							
Pot Metal (used also for faucets)	10			6–8		1			
Shot Metal				56					
Cowper's alloy for turning in the *rose engine* for subsequent printing as letterpress		2					1		
Biddery Ware	16	2	128	4					
Britannia Metal	1	1			2				
Britannia Metal (another formula)		4			4		4		4
Britannia Metal (Lardner's)	8	392			28				8
Britannia Metal (Overman)	3	88	1		7	Steel.			Cadmium.
German Tutania	1	48			4				
Spanish "		24			2	1			
Queen's Metal		9		1	1		1		
Queen's Metal (another formula)	4	100			8		1		
Parisian White Metal	69.8	•	5.5					19.8	4.7
Common Albata or German Silver	20		16					3–4	
Best Albata or German Silver	20		8–10			Iron.		5–6	
White Copper or Tutenag	50		31					19	
Packfong (Chinese)	40.4		25.4			2.6		31.6	
Packfong (more malleable)	5		7					7	
Packfong	53.39		13					17.48	
German Silver (finest quality)	1		2					1	
German Silver (for rolling)	20		60					25	
German Silver (for casting)	20		60	20				20	
German Silver (original formula)	25		40			3		32	
German White Copper	88	Silex Trace	Clay Trace		Trace	Trace		8.75	

SPECIAL FORMULAS.

A metal that expands in cooling; useful in filling defects in iron castings:—

Lead	9
Antimony	2
Bismuth	1

BABBITT metal:—

Copper	1
Regulus of Antimony	1
Tin	10

Melt the copper first, then the antimony, then the tin, strewing charcoal-powder over the crucible to prevent it from burning away. Cast it in bars. It should not be kept hot on the fire any longer than is absolutely essential. Wash the box to be tinned with alcohol, and then sprinkle powdered sal-ammoniac on it; hold it over the fire until the same fuses, then plunge it in melted tin. All parts not to be tinned must be washed with clay. Muriate of zinc, that is, zinc cut with muriatic acid, may be employed instead of the ammoniac, where it can be obtained. When the box is tinned it will take the Babbitt, but it must be pretty hot before the Babbitt is poured in.

Babbitt's English Patent gives the proportions: —

Tin . . . 50
Antimony . . 5
Copper . . . 1

BIRKHOLZ's metal: —

Cast-iron . . . 2 lbs.
Charcoal . . 2 oz.

are heated in a crucible to a white heat; add thereto

Copper . . . 60 lbs.

Heat till both are melted together, then add

Borax . . . 4 oz.
Zinc . . . 38 lbs.

making 100 pounds of the composition.

These are the materials and almost exactly the proportions of the Austrian Navy gun-metal. See BRONZES AND BRASSES WITH THE ADDITION OF IRON (p. 61).

DINSMAN's metal for journal-boxes, patented February 27, 1866: —

Copper . . . 1 lb.
Glass . . . 4 oz.
Borax . . . 1 oz.
Prussiate of Potash ½ oz.
Lead . . . . 8 oz.

In his patent of October 15, 1867, 1 oz. of tin is substituted for the 8 oz. of lead.

An alloy of

Silver . . . 80
Platinum . . 20

resists the tarnishing action of sulphur.

BARON WETTERSTEDT's alloy for sheathing for ships: —

Lead . . . 100
Antimony . . 3

KENNELLY's patent, March 31, 1863. For horse-shoes: —

American Charcoal Iron 30 lbs.
Bone-dust . . . 4 oz.
Manganese . . . 2 "
Ferrocyanide of Potash . 1 "
Hematite . . . 1 "
Wolfram . . . 7 "

melted and cast in molds of the required shape.

Alloy for organ-pipes: —

Lead . . . 50
Tin . . . 25

BURTON's patent, February 12, 1867. For plow-shares: —

Copper . . . 14
Tin . . . 14
Zinc . . . 77
Antimony . . 3
Lead . . . 1

JOHNSTON's patent, November 26, 1867. For dental uses: —

Sodium or potassium, or an amalgam of either, is added to mercury to facilitate its union with silver, tin, cadmium, platinum, etc.

BRANDER's patent, February 12, 1867. For roofing: —

Lead . . . 75
Zinc . . . 25

are made into an ingot, coated with pure tin, and rolled.

BRAYTON's patent, August 6, 1867. For eyelets: —

Tin 4
Zinc . . . 1

TAYLOR's patent, January 8, 1867. For sabots of projectiles: —

Lead . . . 4
Tin . . . 1

for moderate charges. The tin is increased for heavier charges and projectiles to the extent of

Lead . . . 120
Tin . . . 78

With projectiles of 300 lbs. and over, 3 lbs. of copper are added to the alloy for a sabot.

Two new alloys of tin and lead are described in a recent French publication. While containing less tin than is used in common pewter, they are said to possess most of its advantages. They are not acted upon by vinegar, sour wine, or salt-water. The first is made by melting 1 part of tin with 2.4 parts of lead. The lead is first melted and skimmed, then the tin is added, and the mixture is stirred continually with a wooden stick until it begins to cool, to prevent the lead from settling to the bottom. This mixture has the density of 9.64, and its melting-point is 320° Fah. It may be rolled cold, and the plates do not crackle when bent. It takes a very good polish, and tarnishes but little on exposure. It will mark paper like lead, and is so soft that it may be scratched with the nail, but it will not foul a saw or file.

The second alloy is made by melting together in the same way 1 part of tin with 1.25 parts of lead. This alloy is less elastic and harder than the foregoing. It is rather brittle, less malleable than the former, and fills up a file. Neither of these alloys was acted on by boiling with acetic acid for half an hour, and standing in the acid for twenty-four hours longer, nor had salt-water any action upon them: hence they may be useful for some kinds of utensils.

VIGOUROUX'S ALLOY FOR BEER-TAPS.

	Tin.	Antimony.	Nickel.
For the body . .	785	195	20
" " key .	807	175	18
Or	715	215	70

Cock-metal is an alloy of copper and of lead for faucets.

Metallic injection for anatomical preparations: —

Bismuth . . . 1
Lead . . . 1
Tin . . . 1

with the addition of a small amount of mercury.

HACKERT'S patent, May 17, 1864. For knobs and hardware : —

Copper	3
Arsenic	3
Cream of Tartar	2

PFEIFFER'S patent, August 14, 1866 : —

Lead	98
Copper	1
Tin	$\frac{3}{4}$
Antimony	$\frac{1}{8}$
Bismuth	$\frac{1}{8}$

HOOD'S alloy for ship's bolts (England, 1844) : —

Copper	40.4
Zinc	3.8
Lead	16.5
Antimony	5.1

STRUBING'S box metal for bearings (Engl., 1849) : —

Zinc	75
Tin	18
Lead	$4\frac{1}{2}$
Antimony	$2\frac{1}{2}$

(*Oreide.*) An analysis of this new compound by a German chemist gives the following : —

Copper	79.7
Zinc	13.5
Nickel	6.09
Iron	0.28
Tin	0.09

The two latter he regarded as mere accidental ingredients.

According to another formula oreide consists of

Pure Copper	100
Zinc or (preferably) Tin	17
Magnesia	6
Sal-ammoniac	3.6
Quicklime	1.8
Tartar of Commerce	9

See OREIDE.

An alloy for silver coin, etc., upon which experiments have been made in France, and which is said to render the metal more homogeneous than the common alloy of pure copper, less liable to be tarnished by sulphureted hydrogen, and which, when toughened by continued rolling, may be restored by simple heating, is as follows : —

Copper	93
Zinc	72
To be added to Silver	835

MAGEE'S alloy for moldboards of plows. September 9, 1871.

Copper	85
Tin	12
Zinc	3

Aluminium bronze, consisting of copper 90, aluminium 10 per cent (by weight, we suppose), has been stated to have the strength of cast-steel ; a statement apparently confirmed by Mr. Anderson of the Royal Gun Factory in England, and by the experiments of Mr. Morin, Nanterre, where it was found that the tensile strength of this metal is of 5,328 kilogrammes to the square centimeter. At the same time a very important point was determined, — the transverse strength or resistance to being bent. This was found to be for brass, 2.22 ; gun-metal, 0.15 ; aluminium bronze, 0.05. That is to say, three equal bars of these different metals were fastened at one end so as to be perfectly horizontal, a certain equal weight was placed at the free end of each bar, and the result measured by an instrument for that purpose. Brass bent at 2.22 degrees of the instrument, the other metals as indicated above, thus showing the resistance of aluminium bronze to be 44 times greater than brass. The transverse strength, the resistance to permanent flexion, resistance to friction, and the superior resistance to oxidation displayed by this metal, although the latter quality has not yet been accurately determined, admirably qualify it for delicate mechanism and also for purposes where hardened steel was entirely employed. The tenacity of this alloy is astonishing, and is hardly equalled by any other metal ; it is more difficult to cut than gold or brass, but the cut is very clean and smooth.

The alloy of iridium and osmium, called *iridosmine*, is the hardest of all alloys, and is used for pointing the Hawkins " Everlasting Pen " (English).

Mielon, of Paris, proposes a new alloy for the manufacture of all metallic articles, — bells, hammers, anvils, rails, and non-cutting tools. The alloy consists of twenty parts of iron turnings or tin waste, eighty parts of steel, four parts of manganese, and four parts of borax ; but these proportions may be varied.

When it is desired to increase the tenacity of the alloy, two or three parts of wolfram are added. When the cupola is ready, the iron and steel are poured in, then the manganese and borax, and the vessel is filled up with coke.

A number of other alloys are known and used, including some of Eastern origin. The latter are generally of little practical importance. Such are —

Aurum Musivum, same as Mosaic gold.

Clinquant, same as yellow copper ; Dutch gold.

Caracoly, composed of gold, silver, and copper.

Calin, a Chinese alloy composed of lead and tin.

Electrum, an ancient alloy of gold and silver.

The following table affords a ready means for the conversion of decimal proportion into divisions of the pound avoirdupois. The proportions of metals in formulas for alloys are sometimes stated in one way and sometimes in the other.

Dec. of lb.	Oz	dr.	Dec. of lb.	Oz.	dr.	Dec. of lb.	Oz.	dr.	Dec. of lb.	Oz.	dr.
.0039		1	.1289	2	1	.2539	4	1	.3789	6	1
.0078		2	.1328	2	2	.2578	4	2	.3828	6	2
.0117		3	.1367	2	3	.2617	4	3	.3867	6	3
.0156		4	.1406	2	4	.2656	4	4	.3906	6	4
.0195		5	.1445	2	5	.2695	4	5	.3945	6	5
.0234		6	.1484	2	6	.2734	4	6	.3984	6	6
.0273		7	.1523	2	7	.2773	4	7	.4023	6	7
.0313		8	.1562	2	8	.2813	4	8	.4062	6	8
.0352		9	.1601	2	9	.2852	4	9	.4102	6	9
.0391		10	.1641	2	10	.2891	4	10	.4141	6	10
.0430		11	.1680	2	11	.2930	4	11	.4180	6	11
.0469		12	.1719	2	12	.2969	4	12	.4219	6	12
.0508		13	.1758	2	13	.3008	4	13	.4258	6	13
.0547		14	.1797	2	14	.3047	4	14	.4297	6	14
.0586		15	.1836	2	15	.3086	4	15	.4336	6	15
.0625	1	0	.1875	3	0	.3125	5	0	.4375	7	0
.0664	1	1	.1914	3	1	.3164	5	1	.4414	7	1
.0703	1	2	.1953	3	2	.3203	5	2	.4453	7	2
.0742	1	3	.1992	3	3	.3242	5	3	.4492	7	3
.0781	1	4	.2031	3	4	.3281	5	4	.4531	7	4
.0820	1	5	.2070	3	5	.3320	5	5	.4570	7	5
.0859	1	6	.2109	3	6	.3359	5	6	.4609	7	6
.0898	1	7	.2148	3	7	.3398	5	7	.4648	7	7
.0938	1	8	.2188	3	8	.3437	5	8	.4687	7	8
.0977	1	9	.2227	3	9	.3476	5	9	.4727	7	9
.1016	1	10	.2266	3	10	.3516	5	10	.4766	7	10
.1055	1	11	.2305	3	11	.3555	5	11	.4805	7	11
.1094	1	12	.2344	3	12	.3594	5	12	.4844	7	12
.1133	1	13	.2383	3	13	.3633	5	13	.4883	7	13
.1172	1	14	.2422	3	14	.3672	5	14	.4922	7	14
.1211	1	15	.2461	3	15	.3711	5	15	.4961	7	15
.1250	2	0	.2500	4	0	.3750	6	0	.5000	8	0

It is believed that alloys are more perfect when compounded according to atomic proportions, or by multiples of their chemical equivalents, instead of by volumes. The chemical equivalents of the metals upon the hydrogen scale, now most usually adopted, are appended to the following list of metals :—

METALS.

	Melting-point.	Specific Gravity.	Chemical Equivalents.
Aluminium(about)	700 ° F.	2.56	13.75
Antimony .	800	6.712	64.6
Arsenic . .	?	5.8	37 7
Bismuth .	500	9.822	71.0
Cadmium . .	442	8.60	55.8
Cobalt . .	2500	8.53	29.5
Copper . .	2000	8.86	(cast) 31.6
Gold . .	2016	19.3	199.2
Iron (wrought)	3280	17.6	28.
Iron (cast) .	2786	7.807	28.
Lead . .	612	11.44	103.6
Manganese .	2700	6.85	27 7
Mercury (boils at)	670	13.5	202.0
Nickel . .	2500	8.27	29.5
Palladium .	hardly fusible	11 3	53 3
Platinum .	" "	21 5	98.8
Rhodium . .	" "	11.0	52.2
Silver . .	1873 ° F.	10.4	(cast) 108.0
Tin . . .	442	7.28	57.9
Zinc . .	773	6 8	32.3

For a more complete list see ATOMIC WEIGHTS OF METALS ; METALS.

Alloys of greater Specific Gravity than the Mean of their Components.

Gold and Zinc.	Copper and Zinc.
Gold and Tin.	Copper and Tin.
Gold and Bismuth.	Copper and Palladium.
Gold and Antimony.	Copper and Bismuth.
Gold and Cobalt.	Copper and Antimony.
Silver and Zinc.	Lead and Bismuth.
Silver and Lead.	Lead and Antimony.
Silver and Tin.	Platinum and Molybdenum.
Silver and Bismuth.	Palladium and Bismuth.
Silver and Antimony.	

Alloys having a Specific Gravity inferior to the Mean of their Constituents.

Gold and Silver.	Iron and Bismuth.
Gold and Iron.	Iron and Antimony.
Gold and Lead.	Iron and Lead.
Gold and Copper.	Tin and Lead.
Gold and Iridium.	Tin and Palladium.
Gold and Nickel.	Tin and Antimony.
Silver and Copper.	Nickel and Arsenic.
Copper and Lead.	Zinc and Antimony.

(*Remarks.*) The various proportions and relative qualities as to melting-point and gravity are collected from a multitude of sources, the best attainable. The authorities, however, differ somewhat widely, and this can only be accounted for from the fact that so few metals can be obtained pure. The differences in the metals obtained from different localities are often unsuspected, and are fully proven in the variable statements of the cohesion in the tables compiled by Muschenbroek, Tredgold, Barlow, Brown, Rumford, Rennie, Telford, Bramah, and others.

The difficulty that has thus arisen has caused variable statements in the formulas for bell and ordnance casting, and has very considerably affected the exactness of statement in all the alloys, especially the more fusible ones, where the various combinations of lead, tin, and bismuth give such variable results.

It appears to be scarcely possible to give any sufficiently general rules, by which the properties of alloys may be safely inferred from those of their constituents ; for although, in many cases, the working qualities and appearance of an alloy may be nearly a mean proportional between the nature and qualities of the metals composing it, yet in other and frequent instances the deviations are excessive, as will be seen by several of the examples following.

Thus, when lead, a soft and malleable metal, is combined with antimony, which is hard, brittle, and crystalline, in the proportions of from twelve to fifty parts of lead to one of antimony, a flexible alloy is obtained, resembling lead, but somewhat harder, and which is rolled into sheets for sheathing ships. Six parts of lead and one of antimony are used for the large, soft printers' types, which will bend slightly, but are considerably harder than the foregoing ; and three parts of lead and one of antimony are employed for the smallest types, that are very hard and brittle, and will not bend at all ; antimony being the more expensive metal, is used in the smallest quantity that will suffice. The difference in specific gravity between lead and antimony constantly interferes, and unless the type-metal is frequently stirred, the lead, from being the heavier metal, sinks to the bottom, and the antimony is disproportionally used from the surface. In the above examples, the differences arising from the proportions appear intelligible enough, as, when the soft lead prevails, the mixture is much like the lead ; and as the hard, brittle antimony is increased, the alloy becomes hardened and more brittle ; with the proportion of four to one, the fracture is neither reluctant like that of lead, nor foliated like antimony, but assumes very nearly the grain and color of some kinds of steel and cast-iron. In like manner, when the tin and lead are alloyed, the former metal imparts to the mixture some of its hardness, whiteness, and fusibility, in proportion to its quantity, as seen in the various qualities of pewter, in which, however, copper and sometimes zinc or antimony are found. The same agreement is not always met with ; as nine parts of copper, which is red, and one part of tin, which is white, both very malleable and ductile metals, make the tough, rigid metal used in brass ordnance, from which it obtains its modern name of gun-metal, but which neither admits of rolling nor drawing into wire ; the same alloy is described by Pliny as the soft *bronze* of his day. The continual addition of the tin, the *softer metal*, produces a gradual increase of hardness in the mixture ; with about one sixth of tin the alloy assumes its maximum hardness consistent with its application to mechanical uses ; with one fourth to one third tin it becomes highly elastic and sonorous, and its brittleness rather than its hardness is greatly increased.

When the copper becomes two parts, and the tin one part, the alloy is so hard as not to admit of being cut with steel tools, but crumbles under their action ; when struck with a hammer, or even suddenly warmed, it flies in pieces like glass, and clearly shows a structure highly crystalline, instead of malleable. The alloy has no trace of the red color of the copper, but it is quite white, susceptible of an exquisite polish, and, being little disposed to tarnish, it is most perfectly adapted to the reflecting speculums of telescopes and other instruments, for which purpose it is alone used.

Copper, when combined in the same proportions with a different metal, also light-colored and fusible, namely, two parts of copper with one of zinc (which latter metal is of a bluish-white, and crystalline, whereas tin is very ductile), makes an alloy of entirely opposite character to the speculum metal; namely, the soft yellow brass, which becomes by hammering very elastic and ductile, and is very easily cut and filed.

Again, the same proportions — namely, two parts of copper and one of lead — make a common inferior metal, called pot-metal, or cock-metal, from its employment in those respective articles. This alloy is much softer than brass, and hardly possesses malleability; when, for example, the beer-tap is driven into the cask, immediately after it has been scalded, the blow occasionally breaks it in pieces, from its reduced cohesion.

Another proof of the inferior attachment of the copper and lead exists in the fact that, if the molds are opened before the castings are almost cold enough to be handled, the lead will ooze out, and appear on the surface in globules. This also occurs to a less extent in gun-metal, which should not on that account be too rapidly exposed to the air; or the tin *strikes to the surface*, as it is called, and makes it particularly hard at those parts, from the proportional increase of the tin. In casting large masses of gun-metal, it frequently happens that little hard lumps, consisting of nearly half tin, work up to the surface of the runners, or pouring-places, during the time the metal is cooling.

In brass this separation scarcely happens, and these molds may be opened whilst the castings are red-hot without such occurrence; from which it appears that the copper and zinc are in more perfect chemical union than the alloys of copper with tin and with lead.

The malleability and ductility of alloys are in a great measure referable to the degrees in which the metals of which they are respectively composed possess these characters.

Lead and tin are malleable, flexible, ductile, and inelastic whilst cold, but when their temperatures much exceed about half-way toward their melting-heats, they are exceedingly brittle and tender, owing to their reduced cohesion.

The alloys of lead and tin partake of the general nature of these two metals; they are flexible when they are cold, even with certain additions of the brittle metals, antimony and bismuth, or of the fluid metal, mercury; but they crumble with a small elevation of temperature, as these alloys melt at a lower degree than either of their components, to which circumstance we are indebted for the tin solders.

Zinc, when cast in thin cakes, is somewhat brittle when cold, but its toughness is so far increased when it is raised to about 300° Fah. that its manufacture into sheets by means of rollers is then admissible; it becomes the malleable zinc, and retains the malleable and ductile character in a moderate degree, even when cold, but in bending rather thick plates it is advisable to warm them to avoid fracture. When zinc is remelted, it resumes its original crystalline condition.

Zinc and lead will not combine without the assistance of arsenic, unless the lead is in very small quantity; the arsenic makes this and other alloys very brittle, and it is, besides, dangerous to use. Zinc and tin make, as may be supposed, somewhat hard and brittle alloys, but none of the zinc alloys, except that with copper to constitute brass, are much used.

Gold, silver, and copper, which are greatly superior in strength to the fusible metals above named, may be forged, either when red-hot or cold, as soon as they have been purified from their earthy matters and fused into ingots; and the alloys of gold, silver, and copper are also malleable, either red-hot or cold. Fine or pure gold and silver are but little used alone; the alloy is, in many cases, introduced less with the view of depreciating their value, than of adding to their hardness, tenacity, and ductility. The processes which the most severely test these qualities, namely, drawing the finest wires, and beating gold and silver leaf, are not performed with the pure metals, but gold is alloyed with copper for the red tint, with silver for the green, and with both for intermediate shades. Silver is alloyed with copper only, and when the quantity is small its color suffers but slightly from the addition, although all its working qualities are greatly improved, pure silver being little used.

The alloys of similar metals having been considered, it only remains to observe that when dissimilar metals are combined, as those of the two opposite groups, namely, the fusible lead, tin, or zinc, with the less fusible copper, gold, or silver, the malleability of the alloys, when cold, is less than that of the superior metal, and when heated barely to redness they fly in pieces under the hammer; and therefore brass, gun-metal, etc., when red-hot, must be treated with precaution and tenderness. Muntz's patent metal, which is a species of brass and is rolled red-hot, appears rather a contradiction to this; but in all probability this alloy, like the ingots of cast-steel, requires at first a very nice attention to the force applied. It will be also remembered the action of rollers is more regular than that of the hammer, and soon gives rise to the fibrous character, which, so far as it exists in metals, is the very element of strength, when it is uniformly distributed throughout their substance.

The strength or cohesion of the alloys is in general greatly superior to that of any of the metals of which they are composed. For example, the relative weights which tear asunder a bar of one inch square of the several substances stand as follows, — all the numbers being selected from Muschenbrœk's valuable investigations, so that it may be presumed the same metals, and also the same means of trial, were used in every case: —

Alloys.	lbs.	Cast Metals.	lbs.
10 Copper, 1 Tin,	32,093	Barbary Copper,	22,570
8 " 1 "	36,088	Japan "	20,272
6 " 1 "	44,071	English Block Tin,	6,650
4 " 1 "	35,739	" " "	5.322
2 " 1 "	1,017	Banca Tin,	3,679
1 " 1 "	725	Malacca Tin,	3,211

The inspection of these numbers is highly conclusive, and it shows that the engineer agrees with the theory and experiment in selecting the proportion six to one as the strongest alloy; and that the optician, in choosing the most reflective mixture, employs the weakest but one, its strength being only one third to one sixth that of the tin, or one twentieth that of the copper, which latter constitutes two thirds its amount.

See Holtzapffel's "Turning and Mechanical Manipulation," Art. "ALLOYS."

It is much to be regretted that the valuable labors of Muschenbrœk have not been followed up by other experiments upon the alloys in more general use.

One curious circumstance will be observed, however, in those which are given, namely, that in the following alloys, which are the strongest of their respective groups, the tin is always four times the quantity of the other metal; and they all confirm the circumstance of the alloys having mostly a greater degree of cohesion than the stronger of their component metals.

Alloys.	lbs.	Cast Metals.	lbs.
4 English Tin, 1 Lead,	10,607	Lead,	885
4 Banca Tin, 1 Antimony,	13,480	Antimony,	1,060
4 " " 1 Bismuth,	16,692	Zinc,	2,689
4 English Tin, 1 Goslar Zinc,	10,258	Bismuth,	3,008
4 " " 1 Antimony,	11,323	Tin,	3,211 to 6,650

For other matter in regard to metals, see METALS.

The varieties of alloys are considered under their specified heads as follows: —

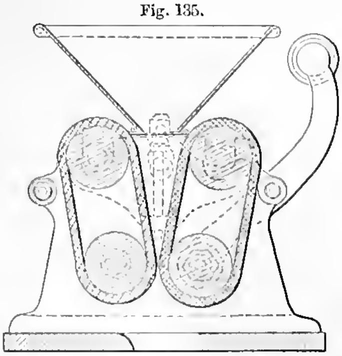
Aich's metal.
Albata.
Aluminium bronze.
Argentum mosaicum.
Artimourantico.
Aurum mosaicum.
Babbitt metal.
Bath metal.
Bell-metal.
Biddery ware.
Billon.
Blanched copper.
Brass.
Britannia metal.
Bronze.
Calin.
Caracoli.
Clinquant.
Electrum.
Expanding alloys.
Fusible alloys.
German metal.
German silver.
German steel.
German tutania.
German white copper.
Gold-solder.
Gun-metal.
Hard solder.
Imitation gold.
Journal-box metal.
Manheim gold.
Minargent.
Mock gold.
Mock platinum.
Mock silver.
Mosaic gold.
Muntz's metal.
Oreide.
Packfong.
Parisian gold-colored alloy.
Parisian white metal.
Petong.
Pewter.
Pewterer's solder.
Pewterer's temper.
Plumber's solder.
Pot-metal.
Queen's metal.
Red brass.
Red tombac.
Rosthorn's gun-metal.
Sabot metal.
Semilor.
Sheathing-metal.
Shot-metal.
Silver-solder.
Soft solder.
Solder.
Spanish tutania.
Speculum metal.
Spelter solder.
Statuary brass.
Stereotype metal.
Tinman's solder.
Tombac.
Tula metal.
Tutenag.
Type-metal.
White brass.
White malleable alloy.
White metals.
Wootz.
Yellow metal.

Al'ma-dy. (*Vessel.*) An African canoe made of the bark of trees.

Al'man. (*Metallurgy.*) A furnace used by refiners for separating metals. See ALMOND-FURNACE.

Al'mond-fur'nace. The word is probably corrupted from Alman (*Allemand*, German) furnace. A furnace used by refiners for separating all kinds of metals from cinders, etc.

Fig. 135.



Wathew's Almond-Peeler.

Al'-mond-peel'er. A small machine used by confectioners and cooks.

WATHEW'S almond-peeler, October 30, 1866. The thin peel is removed from the scalded almond kernels by passing them between two elastic bands of India-rubber, traversing side by side in the same direction, at different velocities.

Almonds came from Persia, and were introduced into England, 1570.

Al'mu-can'ter Staff. An instrument having an arc of 15°, formerly used to obtain observations of the sun's amplitude at the time of its rising and setting, to find the variation of the compass.

Al-pac'a. (*Fabric.*) *a.* A cloth in which the wool of the alpaca (a species of the llama, inhabiting Peru) is combined with wool, silk, or cotton.

b. A soft dress-goods, an imitation of the former; having a cotton chain and woolen filling, plain color and highly finished surface.

Al'pha-bet Tel'e-graph. An apparatus which marks symbols on paper by pressure, as Morse's; or by chemical action, as Bain's; or impresses type on paper, as House's or Hughes's; in contradistinction to one whose indications are observed by the fluctuating position of a needle or needles, as Cooke and Wheatstone's, or the bell-telegraph of Bright. See RECORDING TELEGRAPH.

Al-phon'sin. (*Surgical.*) A kind of bullet-forceps. Named from Alphonsus Ferrier of Naples.

Al'tar. 1. The low ridge which intervenes between the puddling-hearth and the stack.

2. One of the *steps* at the side of a graving-dock. The steps are from nine to sixteen inches in hight, and from nine to fifteen inches wide, except the *broad altar*, which is eighteen inches wide.

Alt-az'i-muths. See THEODOLITE; TRANSIT.

Al-tim'e-ter. An instrument for taking altitudes geometrically, or for measuring vertical angles, as the quadrant, sextant, etc., or the vertical limb of the theodolite.

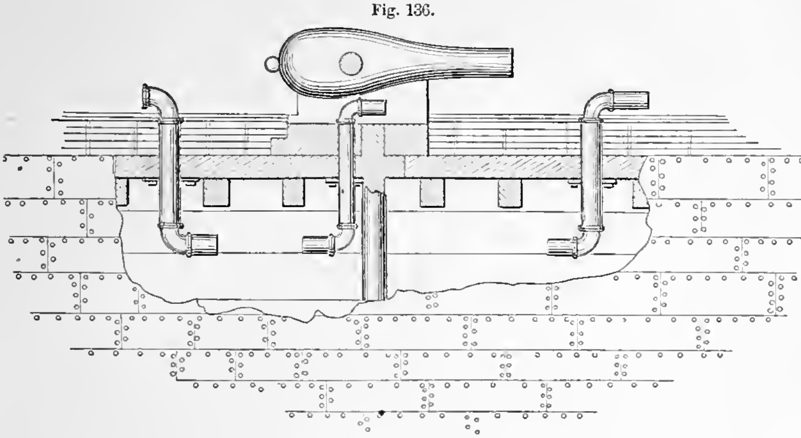
One of the first references to means for measuring height is in connection with the most worthy artificial object in the world, then or now. Thales is said, by Plutarch, to have been in Egypt in the reign of Amasis, and to have taught the Egyptians how to measure the height of the pyramid by its shadow. This is interesting from its association of names and places, but is absurd in itself. Thales went to Egypt to learn, not to teach. During the reign of the same king, Egypt was visited by Pythagoras and Anacreon, the friends of Polycrates of Samos; Pythagoras, among other things, learned to abominate beans, the peculiar aversion of the Egyptian priests. Egypt was also visited about this time by Solon (Herodotus, 1. 30), who came as a student, and afterwards introduced some of the Egyptian laws into his Athenian code.

Al-tin'car. (*Metallurgy.*) A factitious kind of salt used in separating metals.

Al'ti-scope. CLARK, March 13, 1866. This invention consists of an arrangement of lenses and mirrors in a vertical telescopic tube, by means of which a person is able to overlook objects intervening between himself and the object he desires to see. When the sections of the tube are extended, the view is received upon an upper mirror placed at an angle of 45° and reflected thence down the tube to a lower mirror, where it is seen by the observer. The image is magnified by lenses intervening between the mirrors. The telescopic tubes are so connected that each in turn acts upon the next in series, as it comes to the end of its own range, and thus the desired elevation is arrived at. The means of extension is a winch and cords.

STEVENS, January 6, 1863. This affords a means for training guns to a given angle with the axis of the vessel, or on an object, while the gunner remains beneath the gun-deck. There is attached beneath the deck to the pintle of the pivoted gun a graduated index-plate, by which its horizontal bearing may be read. A telescopic tube, with two rectangular bends and with reflecting mirrors at the angles, is so placed as to be used from beneath the

Fig. 136.



Stevens's Altiscope.

deck; two of these may be so situated as to form a base of sufficient length to obtain, by simultaneous observation, the distance by triangulation. Two screw-propellers, working in contrary directions, rotate the vessel so as to bring the guns to bear on the required point.

The upper and lower limbs of the telescopic tube are parallel; the one above deck is presented towards the object, the other to the eye. The image of the object, after being twice reflected, reaches the eye of the observer, whose person is not exposed.

A portable altiscope, adapted to enable a person to look over the heads of a crowd, is formed of a hollow cane with perforations near its respective ends, opposite two reflectors arranged at angles of 45° in the cane. The cane being held vertically, and the upper orifice presented towards the object to be viewed, — a speaker, for instance, — the image is received upon one mirror and passes down the cane to the other, where it is observed by the person. Slides cover the openings when not used for observations, and the cane has then an ordinary appearance.

Al'ti-tude In'stru-ments. Theodolites, sextants, transit instruments, and many others having specific names, are used for taking altitudes, while some of them have also adjustments in azimuth. These are treated specially under the above and other titles, and are also referred to under ASTRONOMICAL INSTRUMENTS.

TABLE OF THE VISIBLE DISTANCE OF OBJECTS IN STATUTE MILES.

Height in Feet.	Distance in Miles.	Height in Feet.	Distance in Miles.	Height in Feet.	Distance in Miles.	Height in Feet.	Distance in Miles.
*.582	1.	11	4.36	30	7.18	150	16.05
1	1.31	12	4.54	35	7.76	200	18.54
2	1.85	13	4.71	40	8.3	300	22.7
3	2.27	14	4.9	45	8.8	400	26.2
4	2.62	15	5.07	50	9.37	500	29.3
5	2.93	16	5.24	55	9.72	1000	41.45
6	3.21	17	5.4	60	10.14	2000	58.61
7	3.47	18	5.56	70	10.97	3000	71.79
8	3.7	19	5.72	80	11.72	4000	82.9
9	3.93	20	5.86	90	12.43	5000	92.68
10	4.15	25	6.55	100	13.1	1 mile.	95.23

* For a statute mile the curvature = 6.99 inches.

The *altitude and azimuth* circle is used for measuring the altitudes and azimuths of stars, as its name implies, and is composed of two graduated circles, one vertical and the other horizontal.

It is thus of general application.

Jean Picard, the great French astronomer, 1620–1684, is said to have been the first to apply the telescope in the measurements of angles.

Al-tom'e-ter. A name for the theodolite, which see.

Al'to-ri'li-e'vo. The high relief of a sculptured object from the plane surface to which it is attached.

The degrees of prominence of the object are indicated by the terms: —

Alto, or *high-relief*, when the object projects more than half its thickness, frequently being attached at a few places to the plane surface.

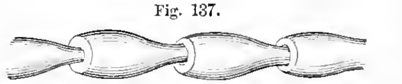
Mezzo, or *demi-relief*, less prominent, say one half the thickness or a little less than half.

Basso, or *low-relief*, a slight prominence, as in medals and coins.

Al'u-del. A pear-shaped receiver, used in the Spanish furnaces for subliming mercury.

The aludels are fitted together longitudinally in a row, the neck of one fitting into the bulb of another, being luted together at the joints with softened

Fig. 137.



Aludel.

loam. The mercury condenses in the aludels, and gradually works its way to the lower one of the series, which is tapped to allow the metal to flow off.

The *aludel furnace* has a vaulted chamber above the fuel chamber, and in the former the blocks of cinnabar are built up. The fumes of the metal pass into a number of strings of *aludels*, and, being condensed, are received in a common duct which leads to a reservoir.

Al'u-min'i-um. Equivalent, 13.7; symbol, Al.; specific gravity, 2.56 cast, 2.67 hammered; fusing-point, 1250° Fah.

Next to silica, the oxide of aluminium (alumina) forms, in combination, the most abundant constituent of the crust of the earth (hydrated silicate of alumina, clay).

Common alum is sulphate of alumina combined with another sulphate, as potash, soda, etc. It is much used as a mordant in dyeing and calico-printing, also in tanning.

Aluminium is a shining, white, sonorous metal, having a shade between silver and platinum. It is a very light metal, being lighter than glass, and only one fourth as heavy as silver of the same bulk. It is very malleable and ductile; does not oxidize when exposed to moist or dry air, is not chemically affected by hot or cold water. Sulphureted hydrogen gas, which so readily tarnishes silver, forming a black film on the surface, has no action upon this metal.

Aluminium is of great value in mechanical dentistry, as, in addition to its lightness and strength, it is not affected by the presence of sulphur in the food, — as by eggs, for instance.

Dr. Fowler, of Yarmouthport, Mass., obtained patents for its combination with vulcanite as applied to dentistry and other uses, February 7 and 14, 1865. It resists sulphur in the process of vulcanization in a manner which renders it an efficient and economical substitute for platinum or gold.

Aluminium is derived from the oxide, alumina, which is the principal constituent of common clay. Lavoisier, a celebrated French chemist, first suggested the existence of the metallic bases of the earths and alkalies, which fact was demonstrated twenty years thereafter by Sir Humphry Davy, by eliminating potassium and sodium from their combinations; and afterwards by the discovery of the metallic bases of barytes, strontium, and lime. The earth alumina resisting the action of the voltaic pile, and the other agents then used to induce decomposition, twenty years more passed before the *chloride* was obtained by Oerstadt by subjecting alumina to the action of potassium in a crucible heated over a spirit-lamp. The discovery of aluminium was at last made by Wohler in 1827, who succeeded in 1846 in obtaining minute globules or beads of this metal by heating a mixture of chloride of alumina and sodium. Deville afterwards conducted some experiments in obtaining this metal at the expense of Napoleon III., who subscribed £1,500, and was rewarded by the presentation of two bars of aluminium. The process of manufacture was afterwards so simplified that in 1857 its price at Paris was about two dollars an ounce. It was at first manufactured from common clay, which contains about one fourth its weight of aluminium, but in 1855 Rose announced to the scientific world that it could be obtained from a material called "cryolite," found in Greenland in large quantities, imported into Germany under the name of "mineral soda," and used as a washing-soda, and in the manufacture of soap. It consists of a double fluoride of aluminium and sodium, and only requires to be mixed with an excess of sodium, and heated, when the mineral aluminium at once separates. Its cost of manufacture is given in the following estimate: for one pound of metal,

16 lbs. of cryolite at 8 cts per pound . .	$1.28
2½ lbs. metallic sodium at about 26 cts per lb.	.70
Flux and cost of reduction . . .	2.02
	$4.00

Aluminium is used largely in the manufacture of cheap jewelry, by making a hard, gold-colored alloy with copper, called aluminium bronze, consisting of 90 per cent of copper and 10 per cent of aluminium. Like iron, it does not amalgamate directly with mercury, nor is it readily alloyed with lead, but many alloys with other metals, as copper, iron, gold, etc., have been made with it and found to be valuable combinations. One part of it to one hundred parts of gold gives a hard malleable alloy of a greenish-gold color, and an alloy of ¾ iron and ¼ aluminium does not oxidize when exposed to a moist atmosphere. It has also been used to form a metallic coating upon other metals, as copper, brass, and German silver, by the electro-galvanic process. Copper has also been deposited, by the same process, upon aluminium plates to facilitate their being rolled very thin; for unless the metal be pure, it requires to be annealed at each passage through the rolls, and it is found that its flexibility is greatly increased by rolling. To avoid the bluish-white appearance, like zinc, Dr. Stevenson McAdam recommends immersing the article made from aluminium in a heated solution of potash, which will give a beautiful white frosted appearance, like that of frosted silver.

F. W. Gerhard obtained a patent in 1856, in England, for an "improved means of obtaining aluminium metal, and the adaptation thereof to the manufacture of certain useful articles." Powdered fluoride of aluminium is placed alone or in combination with other fluorides in a closed furnace, heated to a red heat, and exposed to the action of hydrogen gas, which is used as a reägent in the place of sodium. A reverberatory furnace is used by preference. The fluoride of aluminium is placed in shallow trays or dishes, each dish being surrounded by clean iron filings placed in suitable receptacles; dry hydrogen gas is forced in, and suitable entry and exit pipes and stop-cocks are provided. The hydrogen gas, combining with the fluoride, "forms hydro-fluoric acid, which is taken up by the iron and is thereby converted into fluoride of iron." The resulting aluminium "remains in a metallic state in the bottom of the trays containing the fluoride," and may be used for a variety of manufacturing and ornamental purposes.

The most important alloy of aluminium is composed of

Aluminium . .	10
Copper	90

It possesses a pale gold color, a hardness surpassing that of bronze, and is susceptible of taking a fine polish. This alloy has found a ready market, and, if less costly, would replace red and yellow brass. Its hardness and tenacity render it peculiarly adapted for journals and bearings. Its tensile strength is 100,000 lbs., and when drawn into wire 128,000 lbs., and its elasticity one half that of wrought-iron.

General Morin believes this alloy to be a perfect chemical combination, as it exhibits, unlike the gun-metal, a most complete homogeneousness, its preparation being also attended by a great development of heat, not seen in the manufacture of most other alloys. The specific gravity of this bronze is 7.7. It is malleable and ductile, may be forged cold as well as hot, but is not susceptible to rolling; it may, however, be drawn into tubes. It is extremely tough and fibrous.

Aluminium bronze, when exposed to the air, tarnishes less quickly than either silver, brass, or common bronze; and less, of course, than iron or steel. The contact of fatty matters or the juice of fruits does not result in the production of any soluble metallic salt, an immunity which highly recommends it for various articles for table use.

The uses to which aluminium bronze is applicable are various. Spoons, forks, knives, candlesticks, locks, knobs, door-handles, window-fastenings, harness-trimmings, and pistols are made from it; also objects of art, such as busts, statuettes, vases, and groups. In France, aluminium bronze is used for the eagles on military standards, for armor, for the works of watches, as also watch-chains and ornaments. For certain parts, such as journals of engines, lathe-head boxes, pinions, and running gear, it has proved itself superior to all other metals.

Hulot, director of the Imperial postage-stamp manufactory in Paris, uses it in the construction of a punching-machine. It is well known that the best edges of tempered steel become very quickly blunted by paper. This is even more the case when the paper is coated with a solution of gum-arabic and then dried, as in the instance of postage-stamp sheets. The sheets are punched by a machine the upper part (head) of which moves vertically and is armed with 300 needles of tempered steel, sharpened in a right angle. At every blow of the machine, they pass through holes in the lower, fixed piece which correspond with the needles, and perforate five sheets at every blow. Hulot now substitutes this piece by aluminium bronze. Each machine makes daily 120,000 blows or 180,000,000 perforations, and it has been found that a cushion of the aluminium alloy was unaffected after some months' use, while one of brass is useless after one day's work.

ALUMINIUM ALLOYS.

	Aluminium.	Copper.	Iron.	Silver.	Zinc.
Gold-colored malleable Alloy . . .	1	10			
Parisian gold-colored Alloy . .	10.5	89.3			
White malleable Alloy	2	10			
Hard Bronze . .	10	90			
Non-oxidizable Alloy	25		75		
Hard, bright (like silver) Alloy . .	100			5	
Baur's Patent, Oct. 27, 18'3 . . .	$\frac{1}{10}$ to 3	14–15	Nickel.	Tungsten.	10
Minargent . .	10	1000	700	50	
			White Metal		
Farmer's Patent, Sept. 6, 1854 . . .		65–80	Zinc. $91\frac{11}{10}$; Steel. $6\frac{7}{15}$; Al. $1\frac{7}{10}$		20–35

FARMER's aluminium alloys, patent April 28, 1863. Copper is the first element, aluminium the second; the other light-colored metals are added singly or collectively, as by the following formulas, in which the proportions of atoms are stated. (See article METALS, for table of the chemical equivalents of the metals.

Ag., *Argentum*, — Silver.	Al., *Aluminium*.
Cu., *Cuprum*, — Copper.	Ni., *Nickel*.
Fe., *Ferrum*, — Iron.	Zn., *Zinc*.

The four following formulas produce alloys which, from their color and fineness of texture, nearly resemble gold, whence they are termed chrysoid, being adapted for use in the manufacture of watch-cases, chains, and ornamental jewelry: —

Cu. Al. Ag.

$$\text{Ag.} + 24\ (\text{Al.}_1 + \text{Cu.}_6) = .9180 + .0616 + .0203$$
$$\text{Ag.} + 24\ (\text{Al.}_1 + \text{Cu.}_7) = .9241 + .0570 + .0188$$
$$\text{Ag.} + 24\ (\text{Al.}_1 + \text{Cu.}_8) = .9330 + .0504 + .0166$$
$$\text{Ag.} + 24\ (\text{Al.}_1 + \text{Cu.}_9) = .9400 + .0450 + .0150$$

The three following formulas produce alloys for journal-boxes, etc. for machinery: —

Cu. Al. Zn.

$$\text{Zn.} + 2\ (\text{Al.}_1 + \text{Cu.}_6) = .8643 + .0622 + .0734$$
$$\text{Zn.} + 2\ (\text{Al.}_1 + \text{Cu.}_9) = .9053 + .0435 + .0512$$
$$\text{Zn.} + 2\ (\text{Al.}_1 + \text{Cu.}_{12}) = .9273 + .0333 + .0394$$

These alloys are hard and tenacious, but are characterized by considerable shrinkage in cooling from a molten state, the last-mentioned alloy having considerably more shrinkage than either of the others preceding it. The said alloys have, when drawn into wires of about one thirtieth of an inch in diameter, a tensile strength to the square inch of section in the preceding order of about 90,000, 103,000, and 84,000 lbs.

The following alloys are adapted for gun-metal, being hard, tenacious, laminable, and ductile.

Cu. Al. Fe.

$$\text{Fe.}_1 + (\text{Al.}_1 + \text{Cu.}_{15}) = .9203 + .0267 + .0530$$
$$\text{Fe.}_1 + (\text{Al.}_1 + \text{Cu.}_9) = .9399 + .0446 + .0149$$

Cu. Al. Zn. Fe.

$$\text{Fe.}_1 + \text{Zn.}_1 + (\text{Al.}_1 + \text{Cu.}_{12}) = .8386 + .0302 + .0712 + .0600$$
$$\text{Fe.}_1 + \text{Zn.}_1 + (\text{Al.}_1 + \text{Cu.}_{15}) = .8666 + .0249 + .0588 + .0496$$

The tensile strength of the above alloys when reduced to wire, as above referred to, is for the square inch of section about 82,000 lbs. for the first of the last series of formulas, 84,500 lbs. for the second, and 107,700 lbs. for the last.

Where zinc or tin, or both, enter into the alloys in place of silver, the color of the resultant alloys is somewhat affected, and the luster is diminished.

In the following alloys nickel forms the third element of the combination of the first formula and platinum the third element of the combination of the second formula.

Cu. Al. Ni.

$$\text{Ni. } 1 + 6\ (\text{Al.}_1 + \text{Cu.}_6) = .9129 + .0634 + .0237.$$

Cu. Al. Pl.

$$\text{Pl. } 1 + 21\ (\text{Al.}_1 + \text{Cu.}_6) = .9117 + .0656 + .0225.$$

Those alloys into which platinum is introduced are less affected by acids than those in which silver takes the place of platinum; either the platinum or the silver gives a high luster to the alloy, platinum producing this result in a greater degree than silver.

In those alloys in which are introduced iron or other light-colored metals, which are difficult of fusion, it is preferable to bring the easily fused metals into a molten state, and then to mix those less fusible with them in the form of shreds, particles, fine wire, or thin plates.

Aluminium and its alloys are combined with vulcanite in the patents of Fowler, February 7 and 14, 1865.

According to some analyses, wootz (East Indian steel) is alloyed with aluminium.

LANCASTER's (1858, England) gun-metal: copper, 90; aluminium, 100.

Al'um Leath'er. Leather tanned by a composition of alum and salt. Three pounds of salt and four of alum are used to one hundred and twenty middle-sized skins, which are placed in a tumbling-box with a sufficient quantity of water. The process, with the succeeding operations, is described under TAWING, which see.

Alum was used as a tanning agent by the Saracens.

Al've-o-lar For'ceps. A cutting-forceps or nippers for gnawing away protruding portions of the alveolar ridge, to get a better base for a denture, or to remove points which prevent the healing of the gums.

Am'a a'sa. Pieces of glass used in enameling.

A-mal'gams. An amalgam is a compound of mercury with another metal or metals. It differs from an alloy in possessing mercury as a constituent. Compounds of other metals, with no mercury included, are alloys, whatever may be their comparative quantities or complications. Mercury does not combine with all other metals, but unites with notable readiness with gold, silver, copper, zinc, tin, lead, palladium, and bismuth. It is the great means of selecting and aggregating by absorption particles of gold and silver which are set free by the comminution of their matrix, but are so distributed in the powder as to require a congregating agent. The quartz rock having been pounded or ground so as to reduce it to powder, loosening the firm bond of the rock upon the particles of metal distributed through it, the mercury is well mixed with the dust, water being added to form a pulp. The mercury insinuates itself throughout the mass, and absorbs the precious metals therein. Being removed from the sand and dust of the rock, the quicksilver is set free by sublimation, leaving the non-vaporizable metals in the retort. The quicksilver fumes are gathered and condensed for re-use.

Pliny says, "The most convenient mode of gilding copper is to employ mercury, which is applied in the form of an amalgam to the copper, to enable it to retain the gold leaf when laid thereon." They also understood the art of obtaining mercury by sublimation of cinnabar, or by stamping and application of vinegar. In the process by destructive distillation, the cinnabar was placed in a flat earthen pan covered with a lid and then enclosed in an iron pot luted with clay. Heat being applied, the fumes were condensed and collected in globules on the lid.

In some cases the quicksilver is presented in the form of vapors which condense and unite with the metals to form an amalgam.

Auriferous sands are subjected to the same process of amalgamation by bringing them in contact with a body of mercury. The mechanical processes are described under AMALGAMATORS, which see.

The application of an amalgam of sodium and mercury in extracting precious metals was invented by Wurtz of New York, and patented in the United States, June 27, 1865. Crookes, of England, subsequently to the date of Wurtz's application for United States patent, made application for a patent in England for the same invention.

The extraction of the precious metals by amalgamation has hitherto been much impeded and its cost increased by the presence in the ores of compounds of sulphur, arsenic, antimony, bismuth, or tellurium, which, by covering the gold with a thin film of tarnish, prevent its entering into combination with the mercury. The use of sodium amalgam, under these circumstances, is to prevent the "sickening" and "flouring" of mercury which the presence of these compounds, and especially of sulphate of iron, is so apt to produce.

The official statement of Wurtz's invention is as follows: This invention consists in adding to quicksilver, to be used in the amalgamation of gold, silver, etc., a small quantity of an amalgam of mercury and sodium, or other equivalent metal, as potassium; by this addition the mercury more readily attacks the precious metals. Mercury treated in this way will also form a mercurial film or coating on iron or steel, so as to form amalgamated surfaces, to take the place of the usual copper plates. The mercury so treated is less liable to "flour."

Claim. — First, the combination with quicksilver, when used for the extraction by amalgamation of metals from their ores or their mixtures with other materials, of metallic sodium or metallic potassium, or any other highly electro-positive metal equivalent in its action thereto, as above set forth.

Second, in those amalgamations in which amalgamated plates of copper or other metal are used, the substitution for the plates of copper or other metal of iron coated with quicksilver combined with sodium or other highly electro-positive metal, as above set forth.

Third, the coating of iron, steel, or other metallic surfaces between or under which ores or other materials are crushed, with quicksilver combined with sodium or other highly electro-positive metal, as above set forth.

Fourth, the prevention of the granulation or flouring of quicksilver when used in any method of amalgamating ores or other materials by addition thereto of sodium or other highly electro-positive metal, as above set forth.

The valuable work of Phillips on mining gives the compendium following: A quantity of sodium amalgam dissolved in a hundred times or more its weight of quicksilver is said to communicate to the whole a greatly enhanced power of adhering to metals, and particularly to those which, like gold and silver, are situated toward the negative extremity of the electro-chemical scale. This power of adhesion in the case of the two metals is so great that the resistance which their surfaces, when in their native state, often oppose to amalgamation (a resistance much greater, and more general than has been hitherto recognized, and due to causes as yet uninvestigated) is instantly overcome, whether their particles be coarse or impalpable. Even an artificial coating of oil or grease, which is usually such an enemy to the combination of mercury with other metals, forms no obstacle to immediate amalgamation by this prepared quicksilver. The atoms of quicksilver are, as it is described, put into a sort of polaric condition by a minute addition of one of the metals which range themselves toward the electro-positive end of the scale; so that its affinity for the more electro-negative metals is stated to be so greatly exalted that it seizes upon and is instantaneously absorbed by their surfaces, just as water is absorbed by a lump of sugar, or other porous substance soluble in it.

Such quicksilver even adheres strongly to surfaces of iron, steel, platinum, aluminium, and antimony; an adhesion which, however, in the case of these metals, is not a true amalgamation, there being no penetration into the substance of the metal; so that the superficially adherent quicksilver may be readily wiped off, just as water may be removed from glass. The only metal as yet experimented on, which cannot be enfilmed by the use of sodium amalgam, appears to be magnesium.

Application of Sodium Amalgam to Working Ores of the Precious Metals.

This consists in adding from time to time, to the quicksilver used in amalgamation, about one hundredth part of its weight of sodium amalgam. The frequency with which the amalgam is to be added cannot be exactly specified, as it will be found to depend on a multitude of circumstances, — such, for instance, as the temperature, the purity and quantity of the water used, the ratio borne by the surface of the quicksilver to its mass, the amount and mode of agitation of the quicksilver, the nature of the process and apparatus used, the character of the ore; strength of the amalgam, etc.; so that this important point can only be determined in each case by experience. Some general indications may, however, be derived from the experiments which have been made. It is said that less sodium is requisite in cases in which much water is employed, and when the water is frequently renewed, — as, for instance, in the riffles of a sluice, and in all forms of amalgamators through which a continual current of water is kept running, — since mercurial solutions of sodium are but little affected by water free from acid, alkaline, or saline impurities.

In cases, however, in which but little water is employed, and especially where the ore and quicksilver are ground together into a slime, the water soon becomes alkaline, and oxidation of the sodium sets in, necessitating its frequent renewal.

In such cases the following manipulation is recommended. The whole amount of quicksilver to be used for working up a batch of slimes, say fifty pounds, is prepared by dissolving in it one per cent of amalgam No. 2, or better, two per cent of the soft amalgam No. 1, which dissolves more readily; one half, or twenty-five pounds, is then thrown into the mill with the ore, and, as the incorporation proceeds, certain fractional parts of the other half are added at intervals, varying according to circumstances, until the whole has been introduced. If, as is usual, the quicksilver has been separated from the slimes of a previous operation, it will retain a certain amount of sodium, and therefore require fresh amalgam in proportionately smaller quantities.

No. 1 amalgam contains two per cent and No. 2 four per cent of sodium; the latter is a hard, brittle solid, remarkably infusible, requiring a temperature nearly as high as the fusing-point of type-metal to melt it, and may be cast into ingots, and packed either under petroleum, or in air-tight iron cans filled with dry lime.

In sluicing operations, the soft amalgam No. 1 is, on account of its ready solubility in mercury, most recommended; and in these cases it is practicable to test the quicksilver in the riffles, and ascertain when the magnetic quality requires restoration, by throwing in a few grains of gold-dust. Similar tests are easily applied to slimes, and in amalgamating generally, a slip of tarnished sheet-copper is a suitable agent for such testings. It may be remarked that the amalgam No. 1 is at any time easily prepared from No. 2, by melting it in an iron ladle with its own weight of quicksilver. In copper-plate amalgamation — that is, in cases in which auriferous materials are brought into contact with amalgamated metallic surfaces — it is recommended to substitute for quicksilver itself the pasty amalgam No. 2.

In these modes of amalgamation great economy in wear and tear of apparatus, as well as in first cost, is said to be effected by using plates or surfaces of iron instead of copper. The power of coating or enfilming iron is stated to render these amalgams peculiarly valuable in every form of apparatus for amalgamation which has internal surfaces of iron; for these, becoming coated with quicksilver, immensely extend its chances of contact with particles of gold, so fine as to remain suspended in the water. Other important services are expected by the inventors to arise out of this power of enfilming iron, such as keeping the surfaces of stamps and of other apparatus used in crushing ores continually coated. In like manner, as the power of adhesion of quicksilver to other metals is exalted by the presence of the alkali-metals, so also is its own cohesion stated to be greatly increased. It is rendered more difficult to mechanically divide, and when thus divided again runs instantly together upon contact. Hence new results of great value are said to have been obtained. For instance, the so-called "flouring" or granulation of quicksilver, which in the amalgamation of ores always occasions losses both of the quicksilver itself and of its amalgams with the precious metals, is stated to be reduced to a minimum, or altogether prevented.

The recovery of "floured" quicksilver and amalgams from slimes and similar mixtures is also said to be greatly facilitated and accelerated thereby. For this purpose some sodium amalgam is thrown into the separator, and collects and incorporates all the scattered globules of auriferous amalgam. It is here necessary to call attention to a method of manipulation generally applicable when sodium amalgams are used, and particularly so in all cases in which the ore is ground or agitated with quicksilver in contact with metallic iron. This arises from the liability of abraded particles of iron to adhere to the amalgam.

The following plan is, therefore, in such cases recommended. The amalgam, after separation from excess of quicksilver, and before retorting, is fused in an earthen dish or iron ladle, with, if necessary, the addition of a little quicksilver to make it more liquid; and the iron, which forms a scum on the surface, is skimmed off. The excess of quicksilver may, after cooling, be again separated from the amalgam in the usual way. Any amalgam which adheres to the iron scum is readily detached by boiling in water to remove the sodium. This process depends on the fact that adhesion to the iron totally disappears with the extraction of the last traces of sodium from the quicksilver. It is, in fact, possible to remove all iron from the amalgam by boiling in water without any previous fusion, particularly if the water be made somewhat acid or alkaline. The presence of iron can be readily detected by the magnet, which may also be sometimes used with advantage in separating iron from amalgam after all the sodium has been extracted. There are still other substances which may be found adherent to the amalgam when sodium has been used, such as platinum, or osmiridium, or both, with iron, and these may be freed from the latter by the magnet.

The sodium amalgams prepared in accordance with the recipes of Mr. Crookes are known respectively as *A*, *B*, and *C* amalgams.

Each of these contains three per cent of sodium, in addition to which *B* has a small quantity of zinc in its composition, and *C* a little tin. An amalgam (*A*), of seven times the strength of the above, is prepared in solid bars for shipment when the expense of freight or land carriage is great. Amalgams *B* and *C* cannot be prepared in the concentrated form. It is recommended that one part by weight of amalgam *B* or *C* be dissolved in thirty parts of the mercury which is to be used in the amalgamating, triturating, or grinding machines, and the effect which it produces on the mercury noted from time to time during the operation. If it retain its fluidity and brightness to the end of the operation, it is a sign either that a sufficient amount or too much has been added, and a second experiment should be tried with a less quantity of amalgam. But if it be "floured," or "sickened," or any loss occur, more amalgam may be added until the best proportion is arrived at.

Mr. Crookes states that amalgam *B* will generally be found effective, but if the ore contain an excess of any mineral which has a deleterious action on mercury, more especially if it contain bismuth, it will be advantageous to employ amalgam *C* instead of *B*.

When the best proportion of amalgam *B* or *C* is determined, small quantities of amalgam *A* should be introduced into the mercury, already containing amalgam *B* or *C*, in the proportion of one part of amalgam *A* to one thousand of mercury. This quantity of amalgam *A* can be added every few hours, according to circumstances, but one charge of amalgam *B* or *C* will, it is stated, usually be sufficient for several days. Under some circumstances it will be found advisable to add amalgam *B* or *C* every few days, but a little experience and comparison with the results obtained by the old plan will soon show how these several agents are best utilized.

The process of extraction of the precious metals by the lead-bath will be found under LEAD-BATH FOR THE EXTRACTION OF GOLD AND SILVER.

Other processes for gathering gold (excepting AMALGAMATORS, which see) are included under the general title GOLD-WASHER.

The ore-crushers are described under ORE-STAMPS, etc.; ORE-GRINDING MILLS; ARRASTRAS.

An amalgam of mercury and tin is used to coat the back of looking-glasses and glass mirrors.

This amalgam consists of mercury, 3; tin, 1. It is formed by laying a sheet of tin-foil on a table, covering it with mercury, and then, by a sliding movement, placing the sheet of glass over it.

An amalgam of gold is also used by jewelers to overlay other metals by a fine film of gold, after which the mercury is driven off by heat.

In Mallet's process (English) for preserving iron from rust and ship's sheathing from fouling, the iron is dipped in an amalgam of zinc, sodium, and mercury.

The process is as follows:—

The plates are cleansed in a warm solution of equal parts of acid (sulphuric or hydrochloric) and water. The scale and oxide are removed from the metal by scouring. The plate is then placed in a *preparing*-bath consisting of a saturated solution of hydrochlorate of zinc and sulphate of ammonia. It is then immersed in a bath formed of

Mercury	202
Zinc	1,292

To each 2,240 pounds of which amalgam 1 pound of potassium or sodium is added.

The iron is speedily heated, and is withdrawn before it reaches 680° Fah., at which temperature it would be soon dissolved by the alloy.

A similar process, so far as the manipulation is concerned, is passed through in the palladiumizing process, in which, after cleansing, the plates are immersed in a fused amalgam of palladium and mercury.

Amalgam for the electrical machine:—

Zinc	2
Tin	1
Mercury	4

Melted in the order named, in an iron spoon. Shake the fused amalgam till cold, triturate in a mortar; sift; rub up the powder with lard, and apply with a palette-knife to the rubber of the machine.

Amalgam for silvering the insides of hollow glass spheres:—

Mercury	3
Lead	1
Bismuth	1

A-mal'ga-ma'ting Zinc Plates. Zinc plates for the voltaic battery are amalgamated with mercury, so that no action of the sulphuric acid takes place on the zinc when the circuit is not closed.

To amalgamate the plates, they are first pickled in dilute sulphuric acid (acid 1, water 8) in a stoneware pan. A little mercury, being poured into the pan, is rubbed on both sides of the plate by means of a swab. The plate is washed in clean water, placed on its edge to drain, again rubbed with mercury and drained.

Another method is to clean the plates with emery, pickle, and wash. Then dip the clean plates in a mixture of equal parts by weight of bichloride of mercury (corrosive sublimate) and acetate of lead. Rub with a cloth, and they are ready for use.

A-mal'ga-ma'tor. It appears from Pliny, A.D. 79, that the ancients were acquainted with amalgams, in their uses for separating gold and silver from earthy particles, and in gilding.

Pliny says: "Mercury is an excellent refiner of gold, for on being shaken in an earthen vessel with gold, it rejects all the impurities that are mixed with it. When once it has thus expelled these impurities, there is nothing to do but to separate it from the gold; to effect which it is poured upon leather, and exudes through it in a sort of perspiration, leaving the pure gold behind."

Vitruvius (B. C. 27) describes the manner of recovering gold from cloth in which it has been interwoven. The cloth, he says, is to be put in an earthen vessel, and placed over the fire in order that it may be burnt. The ashes are thrown into water, and quicksilver added to them. The latter unites with the particles of gold, the water is poured off, and the residue put into a cloth, which being squeezed with the hands, the quicksilver, on account of its fluidity, oozes through the pores, and the gold is left pure in a compressed mass. It is commonly stated that the ancients did not understand the art of recovering mercury by retort and receiver, but a description of the apparatus by Pliny (see AMALGAMS) contradicts this. It does not, however, seem to have been much practised.

In the year 1582, Herberer described the washing of gold as he saw it practised at Selz, not far from Strasburg, and at that time quicksilver had long been used for that purpose.

The cinnabar mines of Peru were discovered about 1566 by Garces, who observed the Indians using a native red earth for paint. It does not appear to have come into general use in the silver-mines of Peru, as a means of extracting the silver from the earthy particles, till 1571, when Pero Fernandas de Velasco came to Peru and offered to refine the silver by mercury, as he had seen in the smelting-houses in Mexico. His proposals were accepted, the old methods abandoned, and that of amalgamation pursued as it is practised at present.

In 1572, Hawks writes that "an owner of a mine must have much quicksilver, and as for this charge of quicksilver, it is a new invention, which they find more profitable than to fine their ore with lead."—*Hakluyt's Voyages.*

The number of patents granted in the United States for amalgamators cannot be readily stated, as so many of the crushers, grinders, and arrastras become amalgamators by the addition of mercury. To state the whole number would give an exaggerated view, as many of them are merely mechanical grinders without any specific adaptation to the requirements of the mercurial process. The number of patents for amalgamators in the United States may be approximately stated at two hundred and sixty, January, 1872.

With the exception of the argentiferous galena, silver is generally found in the form of brittle sulphides disseminated through the gangue or vein stone. These particles, in the operation of grinding or stamping, are reduced to a fine powder, which floats off in water in the process of concentration. It becomes necessary, therefore, to apply a gathering agent which will collect them, and the notable activity of quicksilver in entering into combination with the precious metals has caused its selection as the desired agent. The subject is specially treated under AMALGAMS, and the mechanical processes and manipulation are the subject of this article.

The processes and machines for the amalgamation of silver are various, and are : —

The Patio process. The Barrel process.
The Hot process. The Pan process.
The Estufa process.

These will be separately considered.

Succeeding the description of the pan process, a number of examples of Gold Amalgamators are inserted which cannot readily be classed : acting by grinding, stirring, heat, lixiviation, panning, sluices, centrifugal action, electric action, and by mercurial fumes acting on a falling column of pulverized ore.

The Patio Process has long been in use in South America, and is now employed in Mexico, and now or lately in Nevada. It was invented by Medina in 1557. The materials necessary for the reduction of silver by this process are, magistral, common salt, and mercury. The magistral is made from copper pyrites reduced by stamps and arrastras to a fine powder. This is exposed to the air for some months and calcined in a furnace, a little salt being added. The effect is the production of a soluble sulphate of copper.

The silver ore is reduced by stamps and arrastras, or by the more modern forms of ore-grinders, to a fine powder which becomes a mud by the addition of water. The mud or "slimes" is then removed from the arrastra and deposited in walled receivers called "lameros," where it parts with a portion of its water and accumulates till it becomes sufficient to form a "torta." It is then spread to the thickness of about a foot, and after drying to a suitable consistence receives from three to five per cent of salt, which is tramped in by animals. The day after the incorporation of the salt, the magistral and mercury are added, being evenly spread over the "torta," as it is called, to the extent of one per cent of the matter in the heap. The proportion varies according to the richness of the magistral in the sulphate of copper. This is tramped in, and mercury is added ; three and one half to four pounds for every mark of silver supposed to be in the heap. (The mark is eight Spanish ounces of 443.8 gr. each.) This is trodden for four hours. Chemical action now commences, and the mass is carefully sampled from time to time to ascertain its condition and test the sufficiency of the proportion of magistral. If too little, more is added ; if too much, lime is added to prevent loss of mercury. The treading of the torta every alternate day expedites the action. The mules are hitched four abreast and blindfolded, being guided by a halter held by a man standing on the central platform.

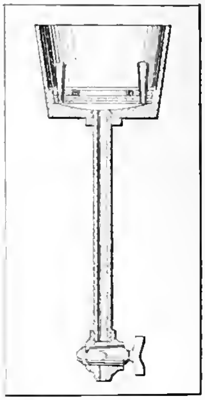
The treading occupies about eight hours on each occasion, and in addition the mass is turned over twice a week with wooden shovels. Incorporation by a mortar-mill would probably be more thoroughly effective with a given amount of power.

Fig. 139.

Strainer (from Tillmann).

When the mercury has absorbed all the silver, the mass is washed by agitation in a series of tanks provided with rapidly revolving stirrers. The rate of motion of these is gradually reduced, and the metallic or heavier particles commence to sink. As soon as a test shows that the upper strata have but a trace of metal, a plug is withdrawn, which allows the earthy particles in suspension to be run off. The amalgam and heavier mineral particles are separated by a subsequent washing, and the amalgam placed in a stone trough, when it is treated with a further amount of mercury and subjected to frequent washings, which bring the amalgam into condition for the strainer, whose upper portion is of leather, and the lower closely woven canvas. A quantity of mercury strains through and is collected. The remaining amalgam is emptied on a leather-covered table and formed into bricks of a triangular shape, which are then ready for the process of retorting.

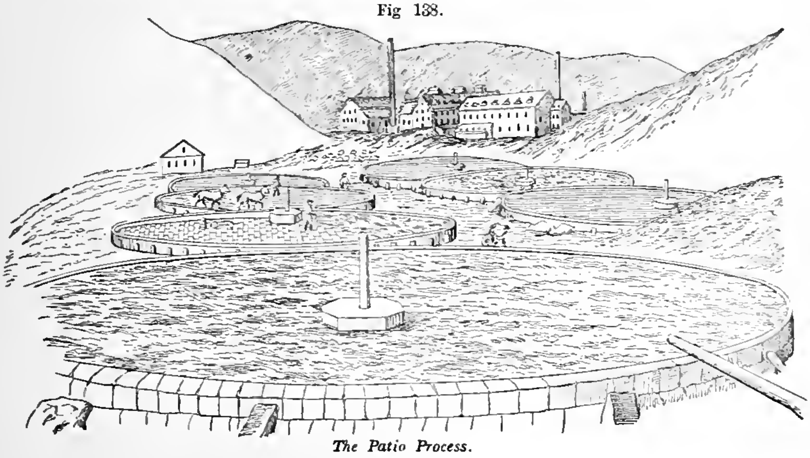
Fig. 140.



Varney's Strainer.

Varney, March 18, 1852. This device is for expediting the straining of the amalgam. The tube, being closed at bottom, is filled with mercury. The amalgam is poured into the vessel, and the cock at the lower part of the tube is then opened. The quicksilver flows out, causing a Torricellian vacuum above it and beneath the strainer. The quicksilver in the amalgam is then forced through the strainer by the pressure of the atmosphere.

Fig 138.



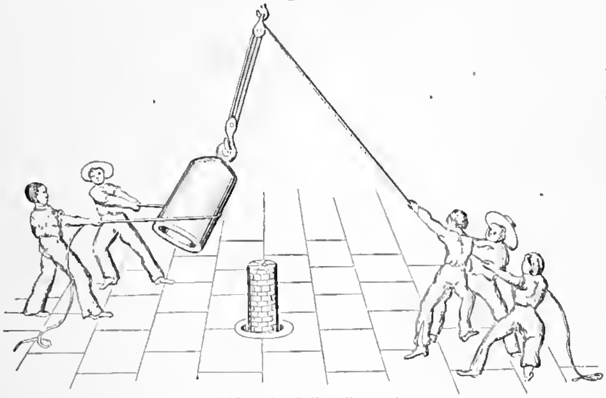
The Patio Process.

In some other strainers the vacuum is produced by mechanical means, such as an air-pump. In some others it is effected by the condensation of steam. If the pipe be long enough it may be obtained by a body of water, but the mercurial column, as in Varney's, brings the apparatus within much more compact limits.

The operation

by which the separation of mercury and silver is effected is conducted by the aid of a large iron or copper bell, which is placed over the amalgam, and around which is kindled a charcoal fire. A circular tank of masonry is constructed below the floor of the burning-house, through which a stream of water is constantly caused to flow; and in this is placed an iron tripod, covered by a round plate, having a hole in its center for the escape of mercury. On this plate are piled the bricks of silver, to such a height as to reach to within a short distance of the top of the bell, which, when placed over them, leaves a space of about an inch between its sides and the column of amalgam. When thus arranged, the bell is lowered over it and the bottom secured, either by lute, or by a water-joint constantly supplied by means of a pipe. Adobes (unburnt bricks) are now built around the arrangement in the form of a hollow wall, leaving an annular space between them and the bell, of about eight inches in width. This is filled with charcoal, which is ignited, and as the temperature increases the mercury becomes volatilized, and passing into the chamber below the floor is condensed, collects in a liquid form, and escapes by an iron pipe into a proper receptacle. The fire is thus kept up during about fifteen hours, after which the apparatus is allowed to cool, and when sufficiently cold the bell is removed, either by a windlass or by means of simple blocks, as shown in the figure.

Fig. 141.



Lifting the Bell (Tilmann).

This silver, which is found to have assumed a porous structure and a beautiful frosted appearance, is called by the Mexicans *plata piña*, and is placed in leathern bags for removal to the smelting-house, where it is assayed and run into bars. The silver obtained by the patio process of amalgamation is in most cases very nearly pure, being generally above 990 fine; and in many cases, as at Guanaxuato, almost absolutely pure silver is obtained.

By the patio process, the amount of quicksilver lost varies from ten to twenty-four ounces per mark of silver, eight ounces (3.556.5 grains), and the time occupied is from fifteen to forty-five days.

The comminution of the ore in arrastras is not a necessary feature of the patio process, as in places where water-power is abundant the ore is reduced to a proper grade of fineness by stamps. A large number of patents for crushers and grinders have been patented in the United States, which are intended to act upon a constant, moderate supply of the broken ore, and reduce it by a succession of operations to the fineness required. See ORE-CRUSHERS, etc.

The nature of the chemical reactions of the *patio* process has been much misunderstood, but Sonneschmid has given a solution which is now accepted. According to his theory, that portion of the silver which exists in the ores in a native state is alone capable of uniting directly with mercury; and if, in grinding with this metal any ores which do not contain silver in the metallic form, a small quantity of amalgam be obtained, it is produced by the action of some substance which in presence of mercury has the property of reducing the silver existing in a state of combination. These compounds, as well as the native metals, are susceptible of conversion into muriate of silver under the influence of muriatic acid liberated by the action of the sulphuric acid of the magistral on a solution of common salt. The muriate of silver thus formed may be destroyed by the addition of alkaline earths, but the silver will then be converted into an oxide which has no longer the property of forming an amalgam with mercury. Farther, that as certain metals have the peculiarity of separating others in a state of purity from the acids with which they are combined, mercury performs this part with regard to silver, by taking from it the muriatic acid, by which a portion of it is destroyed while the remainder forms an amalgam with the liberated silver. This reduction of the silver by the action of muriatic acid on metallic mercury, together with the direct action of the same on that metal, are the two causes occasioning the loss of quicksilver; the direct action of the acid manifesting itself whenever it becomes necessary to make a further addition of magistral. The mercury lost remains in the residue, either in combination with muriatic acid, or in the metallic state; the former representing the deficit known as *consumido* (consumed) and the latter forming that portion of the loss classed as *perdido* (lost).

The HOT PROCESS. This is employed in South America on a peculiar class of ores, containing a large proportion of native silver, or in which that metal occurs in the form of chloride, iodide, or bromide. The ore is roughly stamped, reduced to a certain grade in the arrastra, and washed on an inclined plane, by which the richer portions are condensed into an amount two per cent of the original bulk. The refuse may be graded and sorted, and the richer part subjected to a saving process. The finer portion is removed to a "cazo," a copper-bottomed vessel over a furnace. Water is added to make a liquid paste; when ebullition sets in salt to the amount of from five to ten per cent of the weight of the ore is added. The boiling mass is then stirred, and mercury added at intervals. This must not exceed twice the weight of the silver contained in the ore. This is determined by repeated tests. The operation completed, the liquid matter is removed and added to the ingredients of a "torta," while the solid portions are stored in wooden cisterns, and are subsequently washed and treated as described under the patio process.

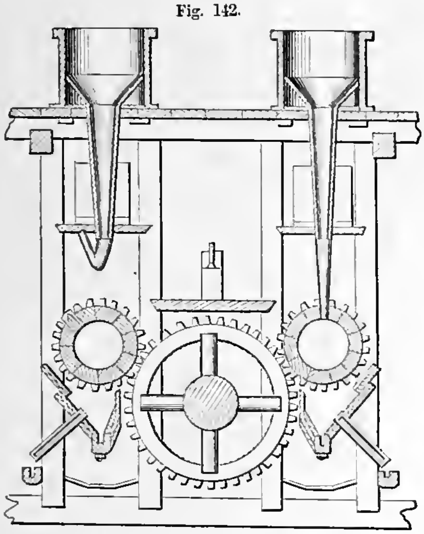
An enlargement of the hot process consists of a larger copper vessel called a "fondon," in which blocks of copper are drawn around as the porphyry blocks of an arrastra. It is heated by a furnace below, as in the case of the "cazo." The charge of the latter may be about 100 pounds, while that of the "fondon" is from 1,200 to 1,500 pounds, and the time for working them off is about six hours in each case. The sulphides are not reduced by this process, and are therefore added to the material of the patio, but do not require the addition of magistral, as they contain a sufficient amount of chloride of copper to convert the sulphides of silver into chloride; the copper is furnished by the attrition of the bottom of the vessel, which is kept clean, by the paddle in the case of the "cazo," and the copper block in the case of the "fondon." The proper proportion of the mercury and the mechanical action prevent the loss of mercury by adherence to the bottom of the pan.

The Estufa Process. In some of the colder and more humid districts of Mexico, a modification of the patio process has been employed. The ground ore, instead of being exposed in the open air on a paved courtyard, as in the ordinary patio process, is placed under a shed, and the usual method of patio amalgamation proceeded with, until the operation is about half completed. The ore is then removed into a chamber termed an *estufa* (stove), which has under it a fireplace six or eight feet long, so connected by side flues with small chimneys as to elevate the temperature of the room containing the ore. Here it is exposed to a gentle heat, and allowed to remain during two or three days, when it is again removed, and the reduction completed by the ordinary method of patio amalgamation.

By this process, the time required for the reduction of the ore is less than by the patio, and the yield of silver greater; the loss of mercury, on the other hand, is more considerable.

The Barrel Process. An apparatus of this description was in use at the latter part of the last century in Germany. It is described as "an apparatus consisting of eighteen small, cylindrical,

Fig. 142.

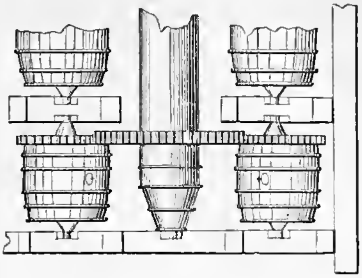


Freiberg Amalgamator (vertical section).

vertical vessels, arranged in a circle, in which the ores were mixed with mercury and constantly agitated by a vertical spindle in each tub, the spindles being worked by a large, horizontal spur-wheel placed in the center."

The amalgamating apparatus of Freiberg consisted of wooden casks arranged in rows and driven by pinions upon their shafts engaged by the teeth of a large spur-wheel. Each cask had a circular aperture, closed by a lid while revolving, and opened as required to receive a charge of roasted ore by a spout from the hopper above; or opened, when in the reverse position, to discharge its contents into the hopper below, after the argentiferous mer-

Fig. 143.



Freiberg Amalgamating Barrels (top view).

cury had been withdrawn at another opening, which at other times is closed by a plug. Each barrel is charged with 300 pounds of water and 1,000 pounds of finely ground ore; fragments of iron are added, the barrels closed and set in motion. When the material is reduced to a paste of the proper consistence, 500 pounds of mercury are added to each cask, and the closed barrels revolved for 16 hours at the uniform rate of 13 revolutions per minute. By the addition of water and subsequent revolution at a slower rate, the mercury is separated from the slimes and collects in a mass below the water, which holds the major part of the earthy particles in suspension, by the aid of moderate agitation. The mercury is then withdrawn by removing a plug and conducting the metal by a hose to a spout and receiver. The passage of earthy particles indicates the time to stop the flow. The plug is replaced, the lid withdrawn, and the muddy residuum discharged into troughs below. The chloride of silver contained in the roasted ores is, as in the Freiberg process, decomposed by agitation with iron fragments, the chloride combining with it to form protochloride of iron, while the reduced metallic silver becomes subsequently dissolved in mercury. The chlorides of lead and copper which may be present are reduced at the same time as the chloride of silver, and enter into the composition of the amalgam produced. The chlorides in the roasted ores are, by trituration with iron, reduced to the state of minimum chlorination, before the addition of the mercury, allowing the latter to act upon the silver immediately, and obviating the conversion of the mercury into calomel, which would not be again reduced and would prove a loss.

The muddy residuum, previously referred to, is re-treated, if sufficiently rich, by roasting, etc.

The amalgam obtained is filtered in the usual manner, and the remainder distilled to sublime the mercury. The metallic result is then refined.

The barrel process at the Ophir and other mines in Nevada is preceded by drying the ores in a kiln; dry stamping, screening through wire sieves, and roasting in reverberatory furnaces for from 4½ to 6 hours. About 5½ per cent of salt is added by portions in the furnace, the ore being stirred, and, before drawing, 1½ to 8 per cent of carbonate of soda is added to decompose the sulphates and chlorides of copper, zinc, etc., and prevent loss of quicksilver.

The roasted ore is then screened and the barrels are charged with it. The charge of each barrel is 2,000 pounds of ore, 450 pounds of iron fragments, and water sufficient; they are then revolved for 3 hours. From 350 to 400 pounds of mercury are now added to each barrel, which are then revolved for 12 or 13 hours at the rate of 12 revolutions per minute. They are then filled up with water, again run for 2 hours, and the water drawn off. The amalgam is strained through a canvas bag to remove a portion of the quicksilver. The tailings are washed in a settler, and thence passed through a series of sluice-boxes into a flume about 600 feet long and 4 feet wide, provided with riffles.

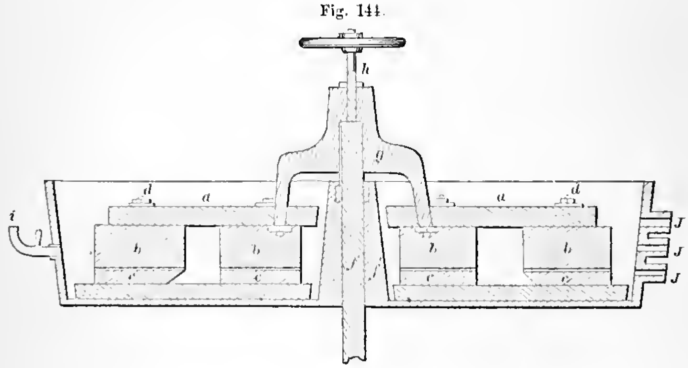
The amalgam is distilled in circular retorts.

The Pan Process. This process was designed especially for operating upon ores of poorer quality, dispensing with roasting incident to the barrel process and to the frequent manipulations and loss of time incident to the patio process. The ores of the mine being sorted into three grades of comparative richness, the first, assaying over $ 90 per ton, and containing a great deal of sulphur and refractory metals, is stamped dry and reserved for the barrel process; while the second, from $ 40 to $ 90 per ton, and the third, from $ 20 to $ 40 per ton, are stamped wet and treated by the pan process.

The crushed ore, after passing through the screen of the stamp-box, is conveyed to the settlers, passing from one to another till the water runs off clear.

The pans are very various in their construction, and a number of them will be shown in this section of the article on amalgamation. The common pan is a round, wooden, or cast-iron tub, six feet in diameter, two feet in depth, and with a flat bottom.

Fig. 144.

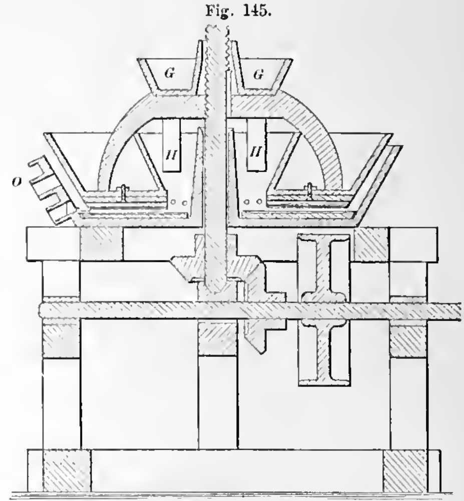


Common Amalgamating Pan.

A false bottom of 1½-inch iron is inserted into this, and a hollow pillar in the center admits the passage of an upright shaft which is generally worked by gearing beneath the pan, capable of communicating to it from fifteen to twenty revolutions per minute. It is sometimes geared much higher.

To the wooden arms *a* are attached the blocks *b*, also of wood, to which are fastened the iron shoes *c*, by means of the bolts *d*, passing up through the arms. Each shoe has also an iron pin, about an inch in length, which fits into the wooden block and keeps the iron-facing steadily in its place. On the shaft *f* passing through the central pillar *f'* is the yoke *g*, which, being fitted with a sliding key, can be raised by means of the screw *h*; and the ends of the yoke itself, being attached to the wooden cross-arms, the mullers will be raised at the same time. Steam is introduced into the pan by the pipe *i*, the discharge being effected by means of the apertures *J*. The false bottom is made one inch less in diameter than the bottom of the pan itself, and has an aperture in the center an inch larger in diameter than the base of the pillar, in which the vertical shaft works. To fasten the bottom in its

Fig. 145.



Norton's Amalgamator.

place, and prevent the mercury from finding its way under it, strips of cloth, about two inches in width, are lapped around the edge of the false bottom, as well as applied against the sides of the pan.

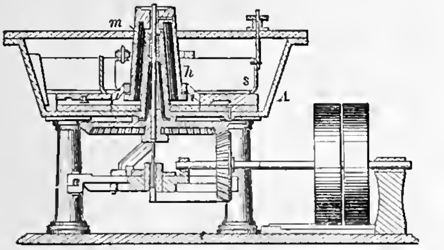
A little iron cement is then poured in, and the bottom secured in its place by means of well-dried wooden wedges tightly driven between the two layers of cloth. These wedges, which are driven quite close to each other, must be somewhat shorter than the thickness of the false bottom, thus leaving a space above them which is subsequently covered with a paste of iron cement, that is allowed to set before using the apparatus. About one-horse power is required to work this pan, which will amalgamate from one and a half to two tons of ore in the course of twenty-four hours.

Norton, September 18, 1860. The annular revolving funnel *G* distributes the powdered material by pipes *H* to the space near the central pillar through which the vertical shaft passes. The grooves in the faces of the muller and bed-plate are arranged in curved lines, so that the material is fed from the center towards the circumference before it reaches the discharge-openings *O*. Projecting points, as the muller and bed-plates, act upon the fed material, and force it from the center as it passes from the pipes *H* into the mill, giving it an eccentric motion, and causing it to come repeatedly under the triturating operation. The balance-rynd with its mullers is adjustable vertically on the shaft to regulate the proximity of the grinding surfaces.

Varney, December 16, 1862, and July 12, 1864.

A stationary bed-plate is attached to the floor of the pan *A*, and has radial grooves which are filled with wood. The rotary-disk has radial, open grooves, formed by the intervals between the sectional pieces which are attached to the face of the disk and form the mullers. The disk itself is an annulus, and is connected by arms *i* with the outer tube *h*, which forms the balance-rynd and rests upon the central pillar *m*, being rotated by the central shaft which is driven by gearing below. The opening in the

Fig. 146.



Varney's Amalgamating Pan.

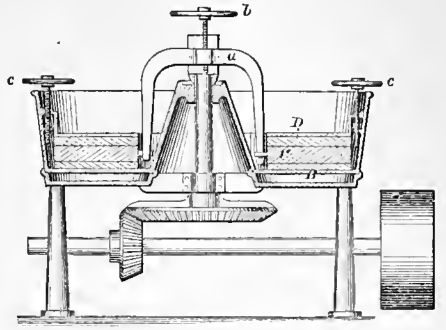
center of the rotating disk is considerably larger than the tube *h*, so as to leave a hiatus in which the material collects. The action is such that the ore will pass outward from this central space between the faces of the upper and lower mullers, and arriving at the peripheral opening is drawn in by spiral scrapers *s*, which are supported from above and return the pulp over the top of the upper muller, to the central space, for a repetition of the operation. The shoes are renewable, and are secured to the disk by rivets which are cast in them. The operation of this apparatus is as follows: The space about the periphery of the lower muller is filled with quicksilver, and the pan nearly filled with pulp of the proper consistency to flow easily; the shaft is now made to revolve at a proper speed, from sixty to eighty revolutions per minute, by which the upper muller is rotated. The pulp between the mullers, by means of the centrifugal force developed, is made to pass out through the radial channels between the dies, as well as between the grinding surfaces of the upper and lower mullers; also into and over the quicksilver, thereby causing amalgamation.

The outward motion of the pulp has the effect of keeping the quicksilver entirely away from the grinding surface, thereby obviating what has often proved a very serious difficulty, namely, the grinding of the mercury.

The rotation of the upper muller causes the pulp in the pan to revolve with it. This current is met by the cuneiform projections and curved plates, and thereby turned toward the central opening in the upper muller. The radial slots between the shoes, running from the central opening to the outward one, allow currents of considerable size to pass with great velocity; and the pulp filling these slots, being continually thrown outwardly, tends to produce a vacuum. By this the pulp in the body of the pan is set in motion, causing a rapid and abundant flow downward at the center, and upward along the inner surface of the pan. The pulp is thus made to circulate until the complete pulverization of the quartz and amalgamation of the metals have taken place.

Coleman, August 18, 1863. The muller of this pan is driven, as are the preceding, by the central vertical shaft which is projected up the central cavity of the annular pan. The shaft supports a balance-rynd *a*, to whose ends are attached the muller *C*, which revolves between two plates *B D*, respectively below and above. The muller *C* has corrugations on its upper and lower surfaces, as have also

Fig. 147.

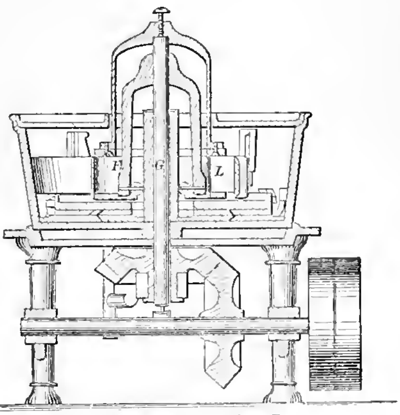


Coleman's Amalgamator.

the surfaces with which it comes in contact. The vertical position of the rotary-wheel or muller is adjusted by the central wheel *b*, and that of the upper plate *D* by the set screws *c*, which are four in number and set at opposite points. By this double adjustment the spaces between the grinding surfaces are gradually approached, as the pulp becomes finer in the progress of the work.

Wheeler, December 8, 1863. The lower face of the rotary-muller has spirally curved grooves which act in apposition to reversedly curved spiral grooves on the bed-plate or stationary muller. Fig. 148 is a vertical section, and Fig. 149 shows the pan in perspective, the muller being raised and turned bottom upwards. The dies *a* are attached to the bed

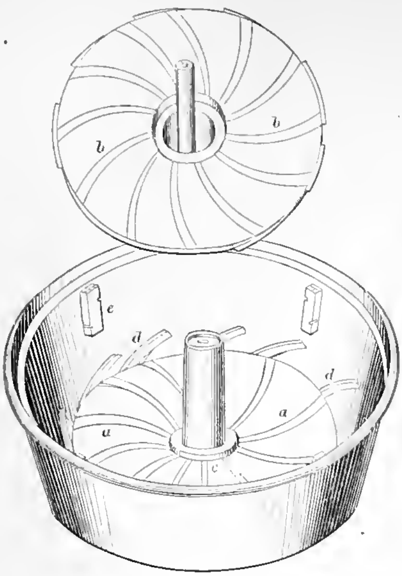
Fig. 148.



Wheeler's Amalgamating Pan.

of the pan, and the shoes *b* to the rotary-disk; this is attached to the hollow cone *F* (see Fig. 148), which is connected to the vertical shaft *G*, and that to gearing beneath the pan. The dies *a* are kept in their places by the central ring *c*, and on the sides by the inclined ledges *d*, under which their edges are wedged. Spiral ribs are fixed on the periphery of the rotary-muller, and act in concert with reversedly spiral ribs *d* attached to the side of the pan to create an upward current in the pulp, which is then swept toward the center again by curved guide-plates attached to the blocks *c* on the

Fig. 149.

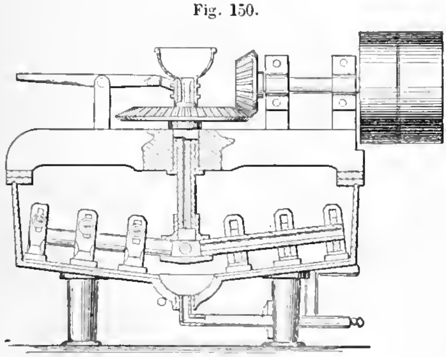


Wheeler's Amalgamator.

inside of the pan. This pan is 4 feet in diameter at the bottom, is said to require from $2\frac{1}{2}$ to 3 horse power to run it effectively, and is geared for sixty revolutions per minute. The muller is connected to its driver by a universal joint. The pan has a double bottom, and is heated by steam admitted to the space thus formed.

WHEELER, July 14, 1863. This machine is constructed for saving the mercury from the pulp or

Fig. 150.

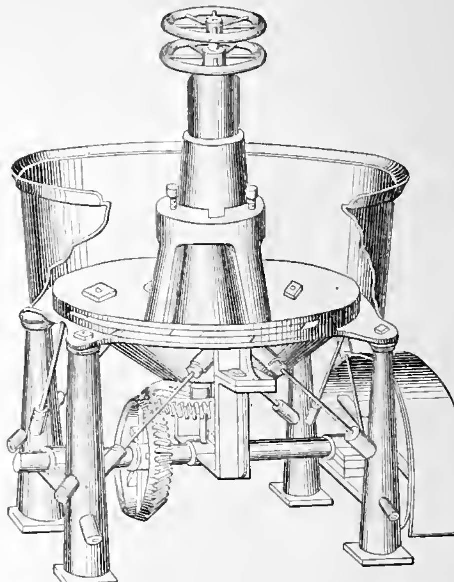


Wheeler's Separator.

waste matter which escapes from the ordinary amalgamators, and consists of a tub with concave bottom and a central depression, in which is a vertical tubular rotary-shaft having arms on which pads are placed, which rub on the bottom and collect the particles of mercury which run down into the central chamber; water is supplied through the hollow shaft, which may be decanted off by a siphon or cocks, and the quicksilver drawn off by the lower tube connected with the gathering-chamber.

HEPBURN AND PETERSON, April 19, 1864. This pan differs mainly from the foregoing in the shape of the bottom, which is inclined towards the center, or shaped like an inverted cone. The shoes are bolted to the face of the conical muller in such a

Fig. 151.



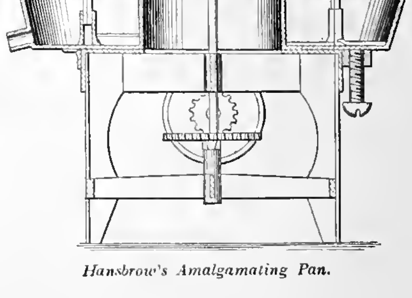
Amalgamating Pan.

way as to leave intervals which form spiral grooves. The dies of the bed are fastened to the pan bottom, and have a similar arrangement, forming spiral conductors whereby the pulp is led towards the periphery; ascending against the sides of the pan, it descends by gravitation over the upper surface of the rotary-muller, is collected at the center, and again driven outwards. A constant and active circulation is thus established without the aid of the curved scrapers shown in some of the preceding examples. The charge for this pan is about 1,400 pounds, and the time requisite for working it from two to four hours, according to circumstances. The rate of running is from fifty to sixty revolutions per minute. The muller is supported upon a balance-rynd, as in the previous examples, and is adjustable vertically by hand-wheels, a thimble, and a tubular screw.

The following two are examples of planetary motion.

HANSBROW, October 27, 1863. The pan has the

Fig. 152.



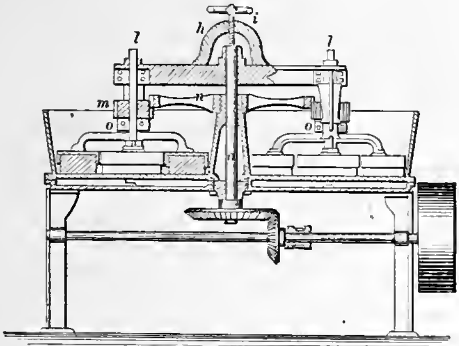
Hansbrow's Amalgamating Pan.

same features as the foregoing, but the action of the mullers is different. The vertical shaft is driven by gearing below, and passes up through a central cavity in the annular pan. On the summit of the shaft is an arm in which are journaled the vertical shafts of the dependent mullers. Each of the latter shafts has a pinion which engages a circular stationary rack on the inner edge of the pan, so that, as the mullers revolve around the main shaft, they have also a rotary motion on their own axes. They thus acquire what is called a planetary motion, rotating as they revolve.

The grinding effect of this motion is very satisfactory, and the mullers wear nearly evenly. The effect of a simply revolving muller is to wear the fastest nearer the periphery, as that passes over a greater frictional surface in describing a larger circle. This difficulty is, however, met by Dodge's patent, described elsewhere in this article.

Kenyon, July 19, 1864. This, like the one immediately preceding, consists of a circular pan, through the center of which passes a vertical shaft. To the upper end of the shaft is attached a cross-head fitted with a yoke, through which a screw passes and rests upon the end of the shaft. At the ends of the cross-head, bows are attached carrying the vertical shafts, upon which are pinions gearing into a stationary wheel. At the end of each shaft are placed arms, and at their ends are irons for receiving the mullers. The mullers have a quadrangular arrangement at the ends of arms o, similarly disposed and radiating from the shafts *l*. As in the preceding example, they have rotation on their own axes by the engagement of their respective pinions *m* with the stationary wheel *n*,

Fig. 153.



Kenyon's Amalgamating Pan.

and have also a revolution in the track formed by the annular pan, owing to the rotation of the shaft *a* and cross-head. The adjustment of pressure of the mullers on the face of the pan is obtained by the set-screw *i*, which passes through the yoke *h* and rests on the shaft *a*. Each muller receives a cycloidal movement.

The process of working in pans is not *merely* a mechanical trituration of the material, and an exposure of it to the contact of mercury. These, of course, are necessary incidents, but the chemical reactions of the constituents are in many respects similar to those described under the patio process and the barrel process of Freiburg and Nevada. The energy of the treatment, however, has the effect of expediting the decomposition of the material and the combination of the precious metals with the mercury.

In operating, the charge having been placed in the pan, the muller is put in motion, and gradually lowered as the material becomes pulverized. Steam is then injected into the mass, raising its temperature to 200° Fahr., care being taken to retain a proper consistence. The muller being slightly raised, quicksilver is added in a shower from a canvas bag, to the extent of from ten to fifteen per cent of the material under treatment; sulphate of copper and sulphuric acid are also added in small quantities; also salt in some cases. Many suggestions of materials to be added are rife among the miners, but appear to be empiric in their character, and not derived from critical chemical consideration of the reactions taking place or required. The running of the pan to complete the amalgamation is continued for three or four hours. The pulp is then thinned so as to flow out of an opening in the bottom of the pan, and is conducted to the separator; or it may be thinned and settled in the pan, reducing the pulp so as to allow the heavier portions to settle, and decanting the mere liquid either by siphon or by opening the cocks on the side of the pan, beginning at the uppermost and proceeding downwards in order, as the condition of the settling renders advisable. Several of the examples show these cocks, but others are so arranged that the pan will tip on its hinges and discharge its contents. In the larger pans, where it is desired to make the work as continuous as may be, the whole charge of the pan is drained off and subjected in a separator to a second process of dividing the earthy particles from the metal, in order that the pan may be expeditiously recharged and proceed with its work.

One of these separators is shown in this article, but the common pan (also shown) is frequently used.

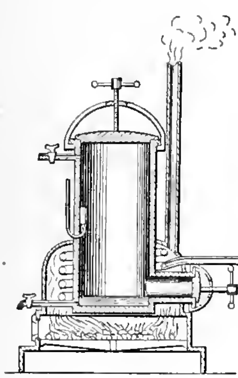
In the separator the pulp is mixed with a large quantity of water, and a regular steady supply kept up, so as to carry off the lighter particles of earthy matter, at first from holes in the upper part of the pan; but as the separation proceeds the discharging-point is gradually lowered, until eventually nothing but the heavier pyrites and liquid amalgam is left. The amalgam is drawn off from the bottom, and the pyrites then scooped out, and after being further washed in another separating-pan, to remove the last traces of amalgam, it is reserved for final treatment by calcination and reduction in barrels. The amalgam is now carefully washed in clean water, dried with flannels, and finally removed to the amalgam-room, where it is strained through thick conical bags of canvas twelve inches in diameter at the larger end, and two feet in length.

After the bags have drained for some time, they are beaten with a round stick to cause a further quantity of the mercury to run off. The hard, dry amalgam is finally removed from the bags and weighed into store.

The mercury run off from the bags is technically known as "charged quicksilver," and after being mixed with retorted mercury is returned to the pan-room for farther use. Charged quicksilver is preferred to the pure metal, as with it amalgamation is found to proceed more rapidly.

Amalgamation of Roasted Ores. In some of the mining districts of Nevada, and particularly in the neighborhood of Austin, where the ores consist of various compound sulphides of silver, containing a considerable amount of antimony, the ordinary pan process, as practised at Virginia City, cannot be advantageously employed. The ores from this part of the State consequently require roasting before being subjected to amalgamation, and then, when worked in the pans, afford better results than those obtained from the ores of the Comstock vein treated in their raw state. Each battery of five stampers will crush (dry) four tons of ore daily, through a wire-gauze screen of forty holes per linear inch. One thousand pounds of this crushed ore are roasted with eight per cent of common salt; the time occupied in the furnace by each charge being, on an average, six hours. Pans are most commonly employed, and are charged with from eight hundred to one thousand pounds of roasted ore, which occupies five hours in working. A mill of ten stampers, with all the necessary furnaces, pans, and appliances, will treat eight tons of ore in the course of twenty-four hours, with a total consumption of about ten cords of wood. It is stated that the loss of silver in the neighborhood of Austin, where the ores contain little or no gold, seldom exceeds seven per cent of the assay value.

Fig. 154.



Spencer's Amalgamator.

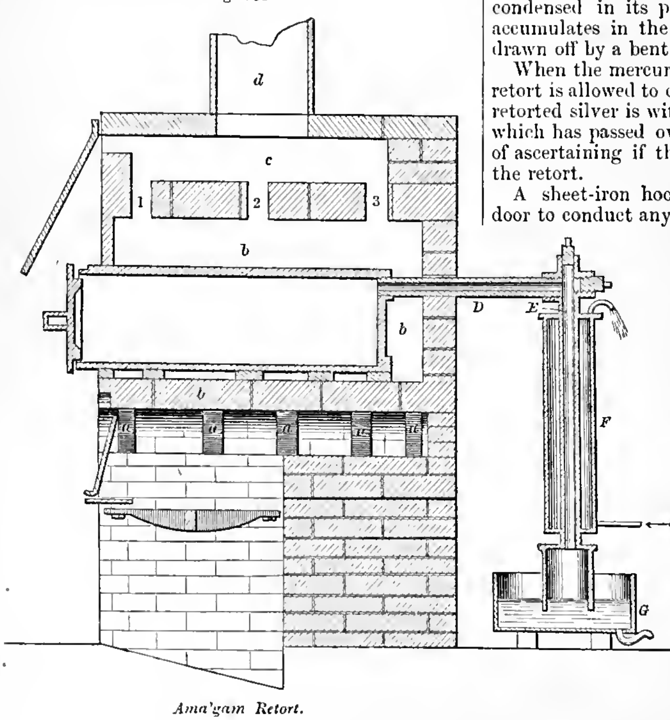
SPENCER, November 22, 1864. The treatment is designed to desulphurize the ore simultaneously with its exposure to the mercurial fumes. The ore, finely pulverized, is placed in a vessel with a small amount of mercury, and the vessel then strongly closed. Heat is then applied, so as to vaporize the mercury. After this treatment the ore is placed in any suitable amalgamating vessel, and washed and treated in the usual way.

RETORTING. The silver or gold amalgam is treated in the assay-office, and the mercury separated by distillation in a cast-iron retort with a luted cover, placed upon an arch of fire-brick, and having another arch above it, being, with the exception of one end, enclosed within a chamber. Fig. 155 shows the arrangement of the retort and chamber. The charge of amalgam is weighed and placed in a semicircular tray divided by a transverse partition. Before being put in the tray the amalgam is coated with milk of lime or a thin wash of clay, a sheet of paper being sometimes placed under it; by these means the amalgam is prevented from adhering to the tray. The tray being placed in the retort, the cover is closed and carefully luted with a thin paste of clay and wood-ashes. The fire is then lighted in the furnace, and the heat very gradually raised until the retort is at a bright red heat. The flame and smoke from the furnace pass through the flues *a a*, etc., up into the chamber *b* and around the retort, the smoke, etc. ascending into the chimney *d* through the flues 1, 2, 3, etc., and the chamber *c*, the draft being regulated by dampers attached to these flues. A horizontal pipe *D* is fitted into the inner end of the retort, and is so connected to the vertical downcast pipe *E* that they admit of being readily separated for cleaning; the pipe *E* terminates in a chamber open at the bottom, and immersed sufficiently deep in a tank of water to keep it air-tight, but not to allow of water being drawn up into the heated retort, and passes through an outer pipe *F*, in which a current of water circulates from below upward, having its exit by a pipe at the top. As the retort becomes heated the volatilized mercury passes through the pipes *D* and *E*, being condensed in its passage through the latter, and accumulates in the reservoir *G*, from whence it is drawn off by a bent tube.

When the mercury has ceased to distil over, the retort is allowed to cool gradually, and when cold the retorted silver is withdrawn, and it and the mercury which has passed over are weighed for the purpose of ascertaining if there has been any leakage from the retort.

A sheet-iron hood is placed over the furnace-door to conduct any escaping vapors into the flues.

Fig. 155.



Ama'gam Retort.

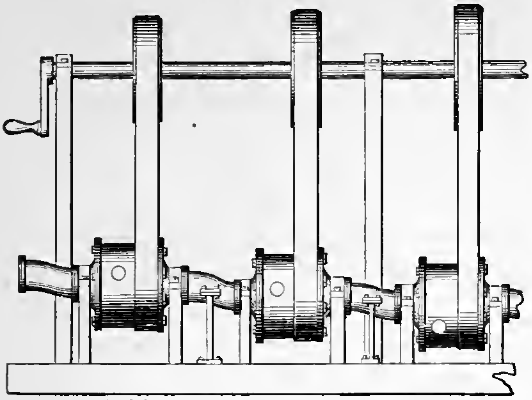
According to Phillips, the cost of working from $ 45 to $ 50 ores by the pan process is, in those portions of the State of Nevada in which water-power can be obtained, nearly as follows: —

	Per ton.
Stamping wet, through No. 6 screens . .	$ 1.50
Milling, including, the loss of mercury, etc.	5.00
Total cost including wear and tear . .	$ 6.50

The loss of mercury amounts to from $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds for each ton of ore containing silver to the amount of from $ 35 to $ 50 per ton.

The BARREL PROCESS as applied to gold is exemplified in many forms. In Fig. 156 the gold is amalgamated in hollow revolving cylinders upon hori-

Fig. 156.

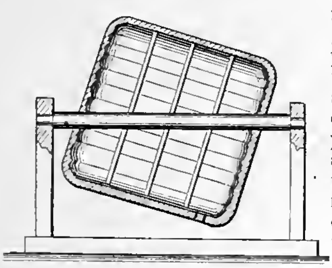


Wright's Barrel Amalgamator.

zontal axes, the trunnions being hollow to admit the pulverized ore from one cylinder into another. The cylinders are connected by flanges or S-pipes with grooves turned into the axes or trunnions, and rings are fitted into the grooves and covered by the flanges; the whole are so connected as to make them water or steam tight, and so arranged as to give a fall of about six inches to each cylinder. The cylinders contain rollers, knives, burnishers, and other analogous arrangements to produce friction, scour the ore, and assist the contact with the quicksilver.

HEATH, February 17, 1863. This machine consists of a cylinder which rotates upon an axis diagonal with the true cylindrical axis, and is formed with a corrugated interior surface, the corrugations running parallel with the true axis and across the end; it is also provided with annular ribs, which project from the inside of the cylinder in a plane parallel to the heads and at right angles to the axis of the cylinder. The effect of the obliquity of the axis of rotation is to make the contents slide and roll as the machine is rotated. A lid admits to the interior, and the latter is also entered by a pipe.

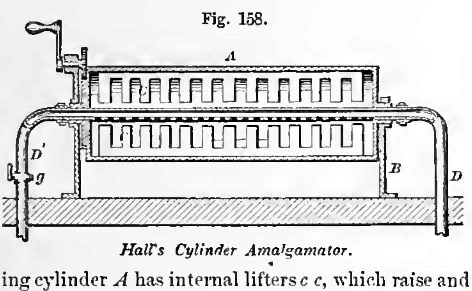
Fig. 157.



Heath's Amalgamator.

HALL, February 28, 1866. The horizontal rotating cylinder A has internal lifters c c, which raise and turn over the pulverized quartz contained therein. The central pipe is stationary, and the cylinder turns thereon. The pipe D connects with a retort, and conducts therefrom the mercurial fumes which pass into the cylinder through perforations in the lower part of the pipe. The end D' of the pipe dips into a vessel of water that condenses any mercurial vapor which passes over when the stopcock g is opened. The cock regulates the pressure of vapor in the cylinder, which has a door by which it is charged and uncharged.

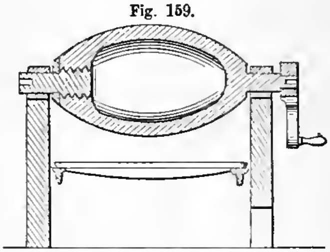
Fig. 158.



Hall's Cylinder Amalgamator.

STAATS, March 13, 1866. The ore is placed in a closed vessel in company with an allowance of quicksilver, and is then rotated on its horizontal axis above the fire in the furnace. The fumes eliminated by the heat from the mercury penetrate the material as it is agitated by the rotation of the vessel.

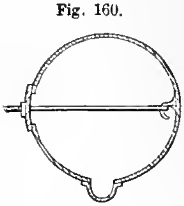
Fig. 159.



Staats's Amalgamator.

STURGES, September 18, 1866. The barrel amalgamator has a pocket to retain the mercury and distribute it to the ore as the barrel revolves. The cylinder is stayed by diametric bolts.

Fig. 160.



Sturges's Amalgamator.

GOLD. *The Battery Process.* In the amalgamation of gold ores the auriferous quartz is broken by a crusher into pieces of about a pound weight, and is then stamped. For wet crushing, stamps are used weighing from five to nine hundred pounds including the stem, and are driven at the rate of seventy blows per minute with a fall of from six to nine inches. They are fed by an attendant whose duty it is to regulate the supply of ore, water, and quicksilver, when that metal is used in the battery for amalgamating the free gold present.

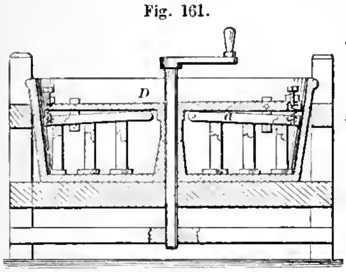
Amalgamation in the battery requires careful attention, principally to avoid the too rapid addition of quicksilver, which should be supplied in very small quantities only.

To amalgamate the free gold in a battery, the quantity of quicksilver to be used is about one ounce weight to each ounce of gold present; this is sufficient to collect the gold and form a dry amalgam. If, therefore, a mill will stamp twenty-four tons of ore in twenty-four hours, and the ore contain an ounce of gold per ton, it will be necessary to put into the battery an ounce of quicksilver every hour. When, in addition to gold, the rock under treatment contains metallic silver, the amount of mercury added must be proportionably increased. More than eighty per cent of the assay value of the gold in the ore may by careful manipulation be thus obtained. The gold amalgam accumulates in the corners and crevices of the battery box, between the dies, on the breast of the mortar, over which the crushed ore is washed into the settling-cisterns, and is even found in considerable quantities adhering to the stamp-shoes. The amalgan. thus obtained is very hard and heavy, and is commonly so rich in gold as to be worth as much as ten dollars per ounce. The crushed ore is taken off from the mortar by a supply of water, equal to the run of ¾-inch pipe to each set of five stamps, passing through screens in the back and front of the box. These screens are made of thin Russia iron perforated with holes punched by sewing-needles.

Auriferous sand is treated in divers amalgamating machines; it being already in a comminuted state, it is not necessary to put it through the battery.

DODGE, May 3, 1864. This invention relates to an arrangement of the rotary-shoes of the machine, whereby the outer ones, which are subjected to the most wear in consequence of having the greatest speed, may always be adjusted so as to run in contact with the bottom of the pan, and the wear thereby compensated for. In the ordinary amalgamating machines the outer shoes, in consequence of being subjected to more wear than the inner ones, soon become comparatively useless.

Fig. 161.



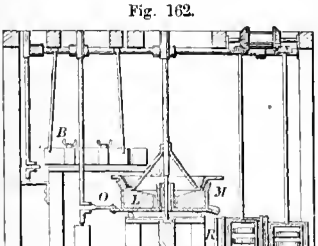
Dodge's Amalgamator.

The adjustable shoes are attached to supplemental bars, which are hinged to the radial arms *D*, and are also connected thereto by springs which permit adjustment of the pressure.

Miscellaneous Machines. The following are diverse in their construction from those previously cited, and are not strictly referable to either of the classes, while partaking of some of the features of the "pan" and the "barrel" process.

CHARLES, September 25, 1866. The inclined panners *B* are suspended by rods from the frame, and are oscillated by machinery. They discharge into a trough which leads the ore-dust and water to a grinding-pan. The ore and water enter the eye of the runner, and pass between it and the bed-plate to the periphery, at which they are discharged by a spout to a series of amalgamating-boxes, each of which consists of a case *R* containing a series of copper pans placed in vertical series. The upper muller *L* has a rotary motion, and the lower one an oscillation, derived from the crank and pitman *O*. The shell *M*, whose floor forms the lower muller, travels on rollers as it oscillates.

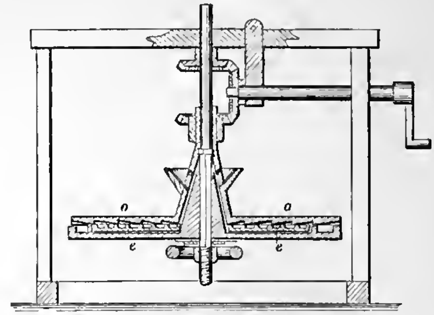
Fig. 162.



Charles's Amalgamator.

BROCK, May 1, 1860. The upper surface of the revolving disk *c* is divided into a number of receptacles, and the lower surface of the disk above it is ribbed. The respective disks revolve in different directions. The receptacles are filled with mercury, and the action of the upper plate *o* is to feed the pulverized ore from the center continually towards the periphery, its gravity keeping it as a film in contact with the mercury upon which it floats and travels. The disks are rotated by the engagement of their respective pinions with bevel-wheels on the driving-shaft.

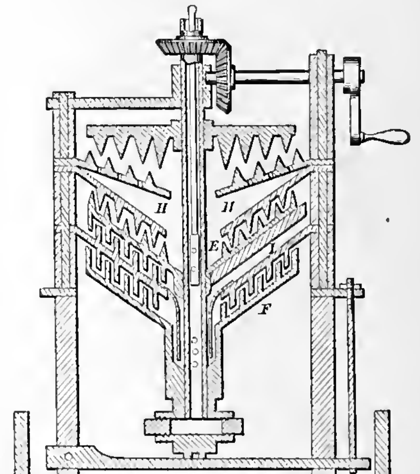
Fig. 163.



Brock's Amalgamator.

BATTELS, January 6, 1863. This apparatus consists of a series of toothed annular plates *H I*, secured to the casing of the machine and inclining down towards the center, and a corresponding number of revolving toothed plates *E F*, mounted on a vertical shaft, forming basins in which the mercury is contained and occupying the spaces between the stationary plates. The material to be washed or scoured, falling on the outer part of the upper stationary plate, is acted on by the teeth of the revolving plate above, and passes inward by its own gravity until it falls on the center of the revolving plate *E* next below, whence it is carried outward by centrifugal action until it falls on the stationary plate *I* next below, and so on to any extent required.

Fig. 164.

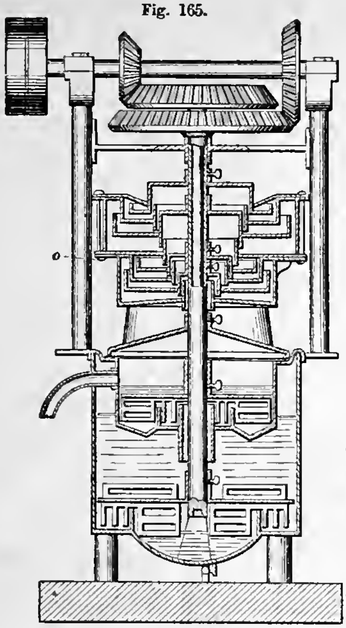


Battels's Washer and Amalgamator.

The vertical shaft is stepped in a lighter-bar, which is raised or lowered to adjust the proximity of the teeth on the rotating disks to those on the stationary ones. The amalgamated metals collect in the central pockets, and are removed therefrom as they accumulate.

PIETSCH, May 3, 1864. The upper part of the

Fig. 165.

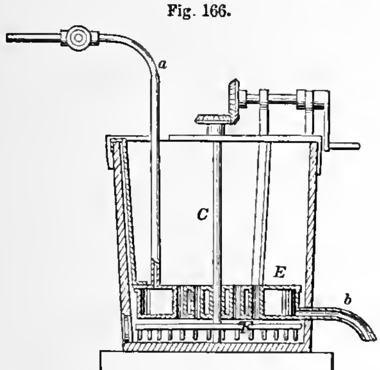


Pietsch's Separator and Amalgamator.

apparatus consists of a double series of pans, the alternate ones revolving in different directions. Each is smooth on its upper surface, but has teeth below, which agitate the material in the pan next beneath. The ore and water are compelled into a tortuous course, falling over the edge of each pan in the series, and being caught by the one beneath. After reaching the point *o*, the ore is led in again to the center, and the action is repeated. The heavy particles accumulate at the bottoms of the pans, and are thence removed to the amalgamators below, where they are agitated by stirrers above and in contact with the mercury which occupies the depressions in the bottoms of the pans; the pans communicate by a central channel.

KENDRICK, May 29, 1866. The agitator *F* operates in the bottom of the tank, being driven by the vertical shaft *C* and the gearing above. The box *E* occupies a position near the bottom of the tank, and is heated by steam introduced by the pipe *a*. *b* is the discharge-pipe for the water of condensation.

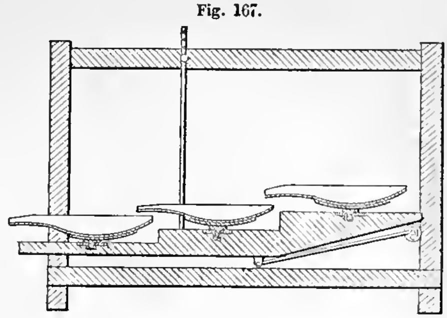
Fig. 166.



Kendrick's Amalgamator.

PECK, February 21, 1865. The pans are arranged in successive order upon steps on the swinging platform. Each pan empties into the one next below it in the series. The belly of each pan has some mercury, and the combined vertical, longitudinal, and partial rotary movement is to settle the heavier matters to the bottoms of the pans and shift the lighter material to the pans next below. The peculiar complex motion of the pans is intended to imitate the hand motion in panning.

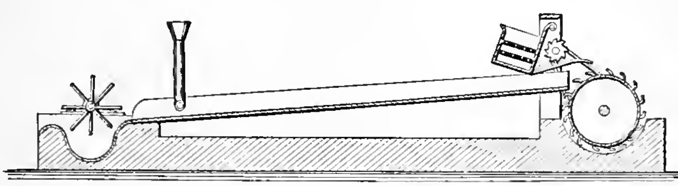
Fig. 167.



Peck's Amalgamator.

PARTZ, July 14, 1863. The powdered ore is distributed in a dry state over the current of mercury flowing upon the inclined surface of the metallic trough. The surface of the latter is amalgamated with mercury, and that which flows to the lower end is re-elevated and again distributed upon the trough. A current of water and an agitator-wheel assist in removing the tailings which reach the receptacle at the lower end of the trough.

Fig. 168.

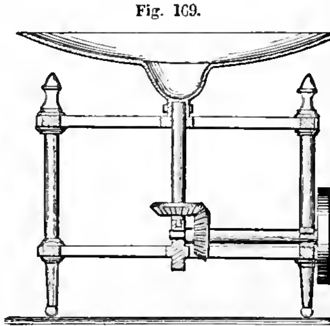


Partz's Amalgamator.

HILL, January 1, 1861. This operates by centrifugal action. The rotating basin has a central depression to contain the mercury, and its surfaces are amalgamated to cause adhesion of the amalgam, as it is formed by the contact of the mercury with the precious metals in the pulverized ore. The water, quartz, and lighter impurities are expelled over the edge of the basin by centrifugal force, while the heavier, valuable results settle into the central pocket.

GARDINER, October 4, 1864, subjects the finely pulverized dust of ores, in connection with mercury, to a powerful agitation and centrifugal action, by placing them in a partially covered revolving pan; the form of the rim prevents the loss of the

Fig. 169.

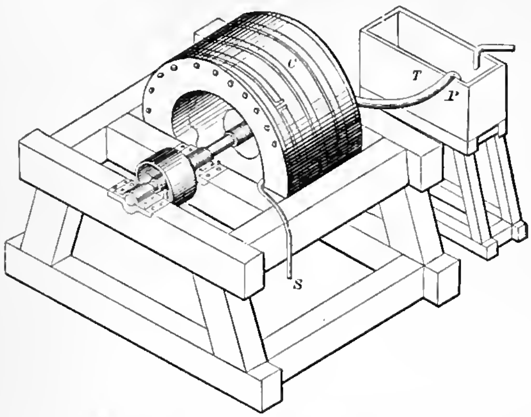


Hill's Amalgamator.

metallic portions, while the lighter impurities are ejected over the edge of the pan, into which a stream of water constantly flows.

WHELPLEY AND STORER, September 11, 1866.

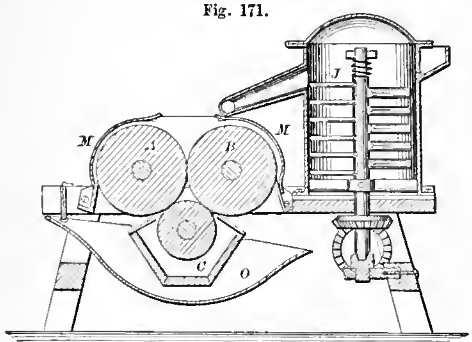
Fig. 170.



Whelpley and Storer's Amalgamator.

The outer cylinder is supported on shaft attached by a hub to an internal plate. The interior of the

Fig. 171.

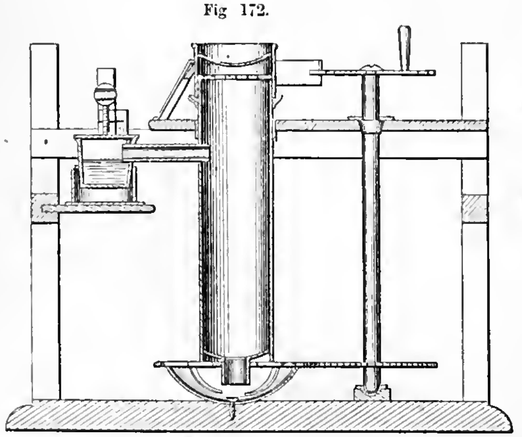


Phelps's Amalgamator.

cylinder is coated with mercury ; the pulp, being introduced during rapid rotation, is spread over the interior surface by the centrifugal force, and the metallic particles are seized and amalgamated by the mercury.

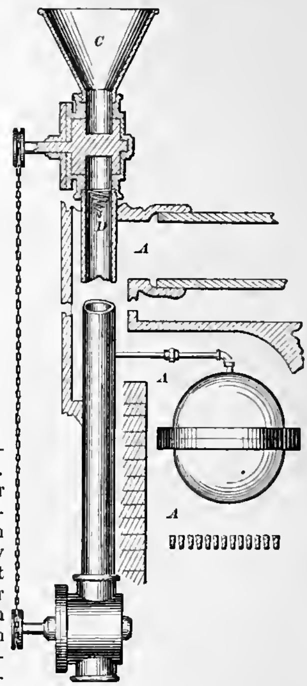
The supply is derived from the tank *T* by pipe *P*, and the tailings discharged by pipe *S*.

Fig 172.



Adams and Worthington's Amalgamator.

Fig. 173.



Day's Amalgamator.

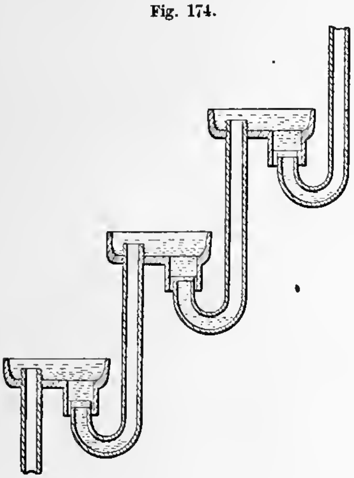
PHELPS, October 18, 1846. The lower roller revolves in a trough of mercury *C*, and distributes it upon the upper rollers *A B*, which are brought into an electric circuit to increase their attractive energy in accumulating the adhering amalgam, which is subsequently scraped off and falls into the receiver *O*. The pulp is supplied to the upper rolls through a spout proceeding from a tank *J*. The jackets hold the ores to the rollers for a specific portion of their revolution.

ADAMS AND WORTHINGTON, February 12, 1864. This invention consists in pulverizing the quartz or metalliferous substances containing precious metals to an impalpable powder, and precipitating and discharging this dust either in a calcined or otherwise prepared condition, in order to isolate the metallic particles from their sulphurous or other foreign combinations, into an atmosphere of hot vapor of quicksilver. On the upper end of a vertical stationary cylinder is fitted a short cylinder, which is made to turn therein, the same being provided with a screen or hopper. Below the stationary cylinder is a pan in which stirrers are made to operate. Communicating with the main cylinder, by means of a tube placed a little below the screen in the upper cylinder, is a furnace or still for distilling the quicksilver which falls with the calcined particles of ore through the stationary cylinder.

DAY, September 26, 1865. The retort is set in a furnace *A*, and delivers fumes of mercury into the vertical tube *D*. The pulverized ore from the hopper *C* is delivered by a feed-wheel in graduated quantities, and falls the length of the tube, at the lower end of which it is delivered by a discharge-wheel, so that the fumes may not escape. The length of the tube may be such as is found sufficient for the purpose, and the respective wheels *E F* are connected by a driving-chain. The particles of the precious metals combine, in falling, with the mercurial fumes with which the tube is charged.

HALL, December 27, 1864. This invention consists of a series of curved pipes connected with quicksilver basins in such a manner that the lower end of the upper pipe and the upper end of the second pipe will enter the bottom of the first basin, the end of the other pipe extending slightly above

Fig. 174.



Hall's Amalgamator.

the bottom of the vessel. The lower end of the latter pipe and the upper end of the pipe *A* enter the bottom of the pan, and so on throughout the whole series.

He claims an apparatus for separating gold from foreign substances, composed of a series of bent pipes or tubes combined by means of a series of connecting-basins containing quicksilver.

To aid the process of amalgamation various processes have been adopted to render desulphurization by roasting more effective, among which may be cited the following: —

RAHT, August 21, 1866, forces air through the mass of fused metal, to remove sulphur, arsenic, and antimony. The apparatus may be similar to the "Bessemer."

RYERSON, August 14, 1866. The ores are heated in a muffle in the presence of a current of air; behind each muffle is a passage in which binoxide of nitrogen is generated, which mixes with the air and sulphurous acid passing from the muffles; the mixture is driven by fans into receivers in company with a steam-jet. The receivers are charged with ore previously desulphurized in the muffles. The sulphurous acid is converted into sulphuric acid, and combines with the base metals in the receiver; the sulphates are dissolved out by water, leaving the gold free; the silver may by the usual method be afterwards precipitated from the solution of mixed sulphates.

WHELPLEY AND STORER, September 11, 1866. In this process the chemical reagents are blown in a finely divided state upon the heated ore by means of a blast of air or steam. The interior of the furnace is stated to have an atmosphere charged with "coal in aërial or air-borne combustion."

FLEURY, July 3, 1866, mixes the sulphurets or tailings with coal-dust, and bakes them into a metalliferous coke. This is ground, heated, and treated with steam, after which it is amalgamated.

BROWER AND CAMPBELL, January 23, 1866. The ores are smelted with a suitable flux, such as carbonate of soda, and the fused mass precipitated into cold water, to disintegrate the mass and expel the sulphur.

WHELPLEY AND STORER, September 11, 1866. The cylindrical vessel is connected with a hopper at one end, an exhaust-pipe at the other end, and has a series of rotary agitating arms attached to a shaft passing through the said cylinder. The hopper has a grating and a feed-brush. Air may be admitted to the cylinder through a grating.

The inventors claim, first, brightening metallic particles in finely pulverized and desulphurized ores, when such brightening is effected on the principle of mutual attrition in a cylinder alternately closed during the brightening process, and opened to set free the charge by means of a valve in the exhaust-pipe, intending to claim for this end the principle of alternately closing and opening the cylinder, so as to do the work in a close cylinder, as well as the combination of the cylinder-valve and exhaust-pipe for the purpose and substantially as described.

A fine grating prevents in the feed-hopper the passage of any but very fine dust into the cylinder.

In their patent of June 13, 1865, they separate metals from mixtures of earth and metal by the action of gravity in counteraction to currents of air in an upright pulverizing-mill, the air moving upward to carry off the finer dust of earthy matter, while the metal falls by its superior gravity.

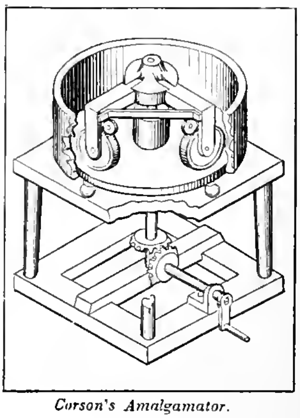
Within the cylindrical case is a revolving shaft provided with blades. The case is provided with a hopper and an air-aperture at the top, and an air-outlet and an outlet for the ore through the conductor at the bottom. The conductor communicates with a box, which is provided with an air-aperture and door. This box communicates with another box by means of a pipe, the latter box being also provided with an air-aperture and a door. A tube leads from this latter box to the center of a spray-wheel which is contained in a box, the bottom of which is covered with water, and the said box is provided with shelves in the upper part.

The same inventors have an apparatus for desulphurizing ores, by roasting, while falling through a chimney above a furnace.

Electric action has been called into play to secure the deposit of gold and silver from the earthy matters with which it is associated, and has also been used to energize the action of the amalgam.

CORSON, May 5, 1868. The ores are contained in an insulated pan or barrel, and subjected to electric action therein. The battery is formed in the pan, and is independent of exterior influences, the anode and cathode being exposed in the slime and amalgam, and connected by a metallic strip.

Fig 175.



Corson's Amalgamator.

For other adaptations of Electro-Metallurgy to the collection of the precious metals, see GOLD AND SILVER, ELECTRO-METALLURGIC PROCESSES FOR COLLECTION OF.

In RYERSON'S apparatus, June 4, 1861, the substance containing the gold and silver is introduced into the cylindrical vessel, provided with a hemispherical or dished bottom, in a finely divided state, together with mercury and water. Superheated steam is introduced by the coiled pipe into the bottom of the vessel, escaping into the mass by a series of small holes. The vapor of the mercury is condensed against the bottom of the cover of the vessel, and falls in a finely divided state through the mass.

The extraction of the precious metals by immersing the powdered ore in a lead-bath has been called amalgamation, but the term is incorrect; it forms an alloy, not an amalgam. It will be considered under LEAD PROCESS FOR EXTRACTION OF PRECIOUS METALS.

BURSILL'S English patent of February 12, 1853, describes a mode which partakes of a combination of the mercurial and lead processes, and may be mentioned here.

He treats auriferous and argentiferous ores with an amalgam formed by the union of mercury with a readily fusible alloy of lead and bismuth; or lead, bismuth, and tin. The ore is immersed in the bath of molten metal.

The lead process preceded the mercurial, at least on this continent, having been practised from time immemorial by the Indians of Peru.

HEISTER'S new process for the reduction of arsenical sulphurets and other refractory ores is thus described by the San Francisco Times. "To all outward appearance the machine is very simple, consisting of three barrels, one of cast-iron and two of wood. The iron cylinder is about half filled with sulphurets or pulverized ore, and revolved over a moderate fire for an hour, keeping it below a red heat. The ore, having been thoroughly heated through, is drawn out into a wooden cylinder, and ten per cent of quicksilver added, and the opening then made air-tight, to prevent the fumes of the quicksilver from escaping. After revolving for two hours, the ore and quicksilver are found to be intimately mixed together, and the gold and silver amalgamated. The charge is then drawn off into the third barrel and diluted with water, and after revolving for two hours the quicksilver and amalgam are drawn off. The secret of this process is in this last barrel, used as a settler; for, in every instance, with the most refractory arsenical sulphurets, and with combinations of lead and iron, the quicksilver is found at the bottom, collecting and forming an amalgam containing over ninety per cent of the gold and silver, while the only appreciable loss in quicksilver in a month's working was what was spilt by carelessness outside. The cost of working five tons a day ought not to exceed $30. A five-horse engine would give an excess of power, and by grading the barrels properly two common laborers on a shift could keep the machine going to full capacity."

A process said to yield excellent results was described in the "Alta Californian" of August 30, 1866. See also "American Journal of Mining" (now the "Engineering and Mining Journal"), Vol. II. p. 43 *et seq.*

"The dry rock is crushed, and afterward submitted to the action of balls in a drum to insure full pulverization, it being desirable that the powder should approach as near the fineness of wheat-flour as possible. A charge of this powdered quartz is then placed in an air-tight cylinder, the interior of which is furnished with a worm of pipes to convey superheated steam therein. Added to the charge is a given quantity of quicksilver, which is first heated by the introduction of ordinary steam; the superheated steam is then turned on, and the whole seethed or boiled for an allotted period. On the top of this cylinder a water-bath is placed, and as the mercurial vapors rise they become condensed. Thus the system of thoroughly impregnating the crushed rock with quicksilver is carried out with efficiency. After thus cooking, the cylinder door is opened, and the whole mass discharged upon a novel shaking-table, which is worked by the power of the steam employed in the previous operation. This table is built of copper on a wooden frame, with rollers and riffles of peculiar construction, which, when it is in motion, give the water, amalgam, and dust the same action as the ocean-surf, — an undertow. As the mass descends, the amalgam, from its metallic weight, gradually clears itself from the quartz-dust, and the result is, that it is all collected in the troughs of the riffles, containing every particle of metal, be it precious or base, the quartz holds. The mode of applying super-heated steam to the crushed rock desulphurizes it, freeing the metals, and all that is necessary is to retort the amalgam to obtain the result of the yield."

The "Journal of Mining," August, 1868, mentions the following as a reported success, but without vouching for it: "Zinc added in small quantities to the quicksilver used in amalgamation augments, in a remarkable degree, the retentive power of the latter for gold and silver. It is stated that one ounce of zinc, or less even, should be used to ten pounds of quicksilver. The action in this case is said to be about the same as when sodium amalgam is employed. The beneficial result is thought to lie in the fact that zinc has a tendency to crystallize in a needle or barb-like form; hence, when disseminated in minute particles through the quicksilver, the power of the latter to take up the atoms of gold and silver with which it may be brought in contact becomes very much intensified. This method of increasing the efficiency of the amalgamation process is said to have been in vogue in the Mexican mines."

Many valuable improvements have first been noticed in the current journals of the day, the "Engineering and Mining Journal," "Scientific American," and "American Artisan." Books and their editors cannot keep pace with the march of improvement, which is incessant, and naturally finds its expression in these scientific papers. See also "Mines, Mills, and Furnaces," by R. W. Raymond, United States Commissioner of Mining Statistics: J. B. Ford & Co., New York.

A-mal'gam, E-lec'tri-cal. For covering the cushions of electrical machines.

Zinc, 1 oz.; grain tin, 1 oz.; melt in an iron ladle, and add mercury, 2 oz. Stir with an iron rod, pour into a wooden box chalked on the inside, and agitate till cold; or stir till cold, and then powder.

The powder is spread on the cushion, which is previously smeared with tallow.

A-mal'gam Gild'ing. Grain gold, 1; mercury 8; unite by gentle heat and stirring.

In using, first rub the brass, copper, etc., with a solution of nitrate of mercury, and then spread a film of amalgam. Heat volatilizes the mercury and leaves the gold behind.

A-mal'gam Ma-nip'u-la'tor. A dentist's instrument to facilitate the preparation of amalgam for filling excavations in carious teeth. It has a cup at one end for taking up the desired amount of filings or powder, and a curved spatula at the other end for combining the mercury with the filings and packing it in the cavity.

A-mal'gam Sil'ver-ing. Silver, 1; mercury, 8; mix with heat, and stir as with gold.

Apply as the gold amalgam, previously using a wash of nitrate.

For silvering the insides of hollow glass vessels, globes, convex mirrors, etc.: —

Lead, tin, and bismuth, each 1 part; melt, mix, and cool to the lowest point at which the alloy will remain fluid; add mercury, 10 oz. Warm the glass, pour in the amalgam, and roll the glass round and round. The amalgam will adhere readily at a certain temperature.

A-mal'gam Var'nish. Melt grain tin, 4; bismuth, 1; add mercury, 1; and stir till cold. Grind fine with white of egg or varnish.

A-man'do-la. A green marble having the appearance of a honey-comb.

Am-a-sette'. A horn instrument for collecting painters' colors on the stone.

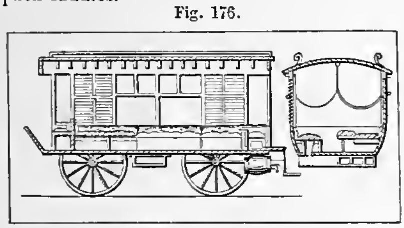
Am'be. A raised stage for a rostrum.

An old chirurgical machine invented by Hippocrates for reducing luxations of the shoulder.

Am'bro-type. A picture taken on a plate of prepared glass, in which the lights are represented in silver, and the shades are produced by a dark background, visible through the unsilvered portion of the glass. — *Webster.* See PHOTOGRAPHY.

Am'bu-lance. Late events in the United States have directed attention to means for the transportation and care of the sick and wounded. Dealing strictly with the mechanical aspects of affairs, it may be stated at once that ambulances are of three kinds, four-wheeled, two-wheeled, and those adapted for pack-saddles.

Fig. 176.



Moses's Ambulance.

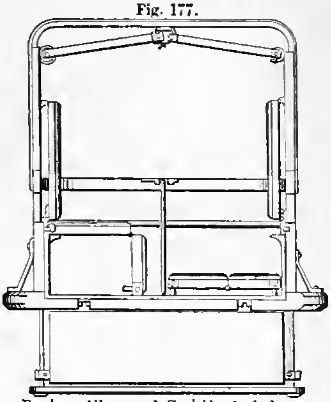
MOSES, September 28, 1858. The sectional folding-seats are arranged along the sides, and may be converted into couches. Hammocks form an upper tier for patients. An adjustable door serves for a table. The surgeon's medicines and implements are carried in cases, which fit in and under the seats, or in drawers under the body of the vehicle. The water-keg is suspended beneath the rear, its faucet defended by the step.

McKEAN, October 11, 1864. The stretchers are run in longitudinally upon rollers, which rest upon a false bottom suspended by rubber springs from the sides of the carriage. The water-vessel is sufficiently elevated to supply the wounded by a flexible pipe which is under their control. A fan is suspended from the roof. The side-slats are vertical and are controlled by a single rod; their beveled edges enable them to shut closely and present plane exterior and interior surfaces.

ARNOLD, April 5, 1864, suspends his cots upon pivots, which enable them to swing in accordance with the inclination of the ground, so as to avoid the rolling motion of the patient. The pivots themselves rest on springs, which give some resiliency when the carriage receives vertical motion, and thereby lessen the jar.

RUCKER, ALLEN, AND SMITH, November 6, 1866. This is a double or single tier ambulance. Each couch of the lower tier is divided longitudinally and hinged. It may lie flat upon the floor, while the upper tier is occupied by other patients; or it may be bent so as to form a seat and support, while the stretchers of the upper tier are placed on edge against the carriage sides and form backs for the seats. The sides are separately adjustable.

Fig. 177.



Rucker, Allen, and Smith's Ambulance.

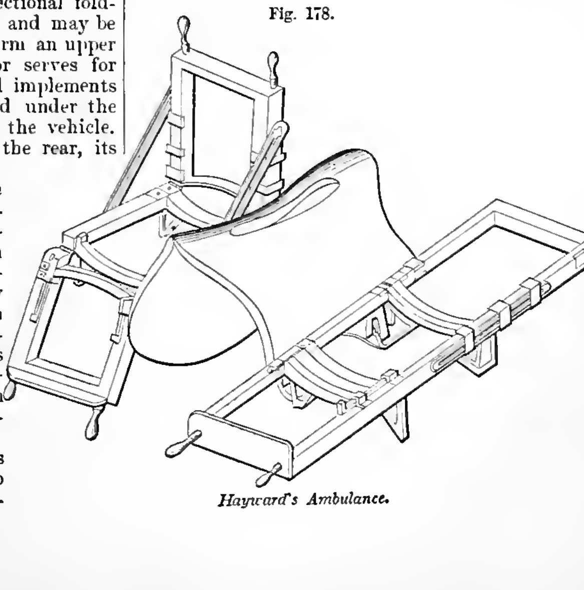
The two-wheeled ambulances are spring carts with provision for recumbent or sitting patients.

HAYWARD, May 16, 1865. The stretchers may be adjusted for recumbent or sitting patients, the legs operating to support them in either capacity when the stretchers rest on the ground. The pack-saddle has wedge-shaped sockets to receive corresponding wedge-shaped blocks on the legs of the stretchers.

SITS, 1863, WILKINS, 1864, SLATTER, 1865, and others have patented improvements which might be cited would room permit.

This description of service was brought to great efficiency by Baron Larrey, during the wars of Napoleon I. The experience was almost lost in the peace interval, judging by the ambulance arrangements in the Crimea, 1854. At the battle of the Alma, in which 1,986 British and 1,360 French were killed or wounded, the generals of both armies

Fig. 178.



Hayward's Ambulance.

appear to have been taken by surprise. The English were least efficient, the French improvised chairs or panniers slung over the backs of mules, like one of the illustrations preceding. Our own service, 1861-65, was well performed, after things got in running order. Perhaps the Crimean heroes might say the same, with the concluding proviso.

Am'bu-la'tor. Sometimes called a perambulator. An instrument for measuring distances. See ODOMETER. The word "ambulator" is often erroneously applied to a velocipede, and to a traction-engine, whose mode of propulsion is by oscillating bars whose feet come in contact with the ground in somewhat similar manner to the natural action of the legs of animals or of man. The light carriages driven by hands or feet will be considered under the heading VELOCIPEDE. See also TRACTION-ENGINE.

A-mer'i-can Leath'er. An enameled cloth imitating leather.

Am'i-ci's Prism. A glass prism mounted beneath the stage of a microscope to obliquely illuminate an object beneath the stage. The prism has a flat-bottom side and two lenticular sides, combines the refracting and reflecting powers, and throws a converging pencil of rays upon the object. It has three adjustments: one on a horizontal axis to direct the rays upward at the required angle; one for distance from the axis of the microscope, to vary the obliquity; one by rotation on a vertical axis, to determine the direction whence the rays shall proceed.

Am'mo-ni'ac-al En'gine. This motor seems to be yet in an inchoate state, but has received some attention in Europe. The machine described is the invention of M. Froment. The London "Mechanics' Magazine" thus refers to it (it appears to have been at work — or rather in action, for it was not usefully employed — at the Paris Exposition): "Strong liquid ammonia is used in the boiler, and the vapor generated is said to be a mixture of at least eighty parts of ammoniacal gas and twenty parts of steam, so it may be fairly called an ammoniacal engine. The principal recommendations of ammonia, when applied as a motive-power, consist in the small amount of fuel required, and the short time it takes to get up the steam, so to speak. The economy in fuel is very considerable, being about one fourth of that required to generate steam alone. As regards the boiler, it may be of either of the ordinary forms, the only complete novelty being the apparatus for condensing the steam and ammonia. The gas disengaged (about six atmospheres at 110° Centigrade with an ordinary solution of ammonia) does its work in the cylinder and then escapes into the tubes of a condenser, where the steam is condensed and the gas is cooled. The gas then meets with a cold liquid from an injector, which dissolves it, and the solution is carried on into a vessel called the 'dissolver,' from which it is pumped back into the boiler to do its work over again. The liquid for the injector is taken from the boiler, and is cooled before meeting with the ammoniacal gas by passing through a worm surrounded with cold water."

"Ammonia, at the temperature of our atmosphere, is a permanent gas of well-known pungent odor. It is formed by the union of three volumes of hydrogen to one of nitrogen, condensed into two volumes. Its density is 596; air being 1,000. The density of the liquid, compared with water, is 76, or about one quarter lighter than that liquid. Its vapor at 60° Fahr. gives a pressure of 100 pounds to the square inch, while water, to give an equivalent pressure, must be heated to 325° Fahr. The volume of ammoniacal gas under the above-named pressure is 983 times greater than the space occupied by its liquid, while steam, under identical pressure, occupies a space only 303 times greater than water." — *Annals of Chemistry* (French).

"Ammoniacal gas, which is an incidental and abundant product in certain manufactures, especially that of coal-gas, and which makes its appearance in the destructive distillation of all animal substances, is found in commerce chiefly in the form of the aqueous solution. It is the most soluble in water of all known gases, being absorbed, at the temperature of freezing, to the extent of more than a thousand volumes of gas to one of water; and at the temperature of 50° Fahr., of more than eight hundred to one. What is most remarkable in regard to this property is that, at low temperatures, the solution is sensibly instantaneous. This may be strikingly illustrated by transferring a bell-glass filled with the gas to a vessel containing water, and managing the transfer so that the water may not come into contact with the gas until after the mouth of the bell is fully submerged. The water will enter the bell with a violent rush, precisely as into a vacuum, and if the gas be quite free from mixture with any other gas insoluble in water, the bell will inevitably be broken. The presence of a bubble of air may break the force of the shock and save the bell.

"This gas cannot, of course, be collected over water. In the experiment just described, the bell is filled by means of a pneumatic trough containing mercury. It is transferred by passing beneath it a shallow vessel, which takes up not only the bell-glass, but also a sufficient quantity of mercury to keep the gas imprisoned until the arrangements for the experiment are completed.

"The extreme solubility of ammoniacal gas is, therefore, a property of which advantage may be taken for creating a vacuum, exactly as the same object is accomplished by the condensation of steam. As, on the other hand, the pressure which it is capable of exerting at given temperatures is much higher than that which steam affords at the same temperatures; and as, conversely, this gas requires a temperature considerably lower to produce a given pressure than is required by steam, — it seems to possess a combination of properties favorable to the production of an economical motive-power.

"Ammonia, like several other of the gases called permanent, may be liquefied by cold and pressure. At a temperature of 38.5° C., it becomes liquid at the pressure of the atmosphere. At the boiling-point of water it requires more than sixty-one atmospheres of pressure to reduce it to liquefaction. The same effect is produced at the freezing-point of water by a pressure of five atmospheres, at 21° C. (70° Fahr.) by a pressure of nine, and at 38° C. (100° Fahr.) by a pressure of fourteen." — *Barnard.*

LAMM'S Ammonia Engine is driven by the expanding pressure of liquefied ammonia, and is specially adapted for small powers, especially portable engines for street cars, etc. The ammonia is to be liquefied at a central station, at which the reservoirs on the cars receive their supply.

The engine is driven by the force of the gas upon the piston, and the gas is exhausted into a body of water surrounding the gas reservoir. The absorption of the gas by the water is instantaneous, and the water derives an increment therefrom which is imparted, through the walls, to the contents of the reservoir. See "Engineering and Mining Journal," Vol. X. p. 65.

Am-mo'ni-um. The hypothetical metallic base of ammonia. Equivalent, 18; symbol, NH_4. Only known in its combination with mercury as an amalgam.

The salts of this metal, volatile and otherwise, are used in pharmacy, chemistry, and as stimulants.

Am'mu-ni'tion. In its most comprehensive signification, this includes artillery and small-arm projectiles with their cartridges and the percussion-caps, friction-primers, etc., by means of which they are fired; also war-rockets and hand-grenades. For artillery, when the projectiles, their cartridges, primers, etc., are packed in the same box, it is designated in the United States service as *fixed ammunition;* this is the description furnished for field and rifled siege artillery. For larger calibers, the projectiles and cartridges are put up in separate boxes, round solid shot, however, being generally transported loose.

Up to 12-pounders for smooth-bore ordnance the cartridge is attached to the projectile; above that caliber the shell or case-shot are filled, the fuse inserted, and the sabot attached; in this case, the projectile is said to be *strapped;* shells of 8-inch caliber and upwards are seldom filled previous to issue, this operation being performed as they are required at the place where they are used. Projectiles for rifled artillery are always separate from their cartridges.

Fixed ammunition for field artillery is put up in boxes of uniform size for each caliber, each containing a given number of rounds, viz.: —

Smooth-bore 6-pounder gun . .	14
Smooth-bore 12-pounder gun . .	8
Smooth-bore 12-pounder howitzer .	12
Smooth-bore 24-pounder howitzer .	6
Smooth-bore 32-pounder howitzer .	4
Rifled-bore 3-inch or 10-pounder gun	10

Ammunition for small-arms is known in the United States service as *small-arm cartridges.* In these the bullet and cartridge are invariably put up together in boxes of 1,000, except some descriptions of patented cartridges, which are put up in boxes containing 600 or 1,200, and repeating-cartridges, as Spencer's, in which the box is made to contain a multiple of the number which fills the breech-chamber.

Rules have been laid down for determining the proper supply of ammunition of each description for an army in the field.

That assumed by the British authorities allows 300 small-arm cartridges per man for six months' operations; of which an army of 60,000 men should have 2,680,000 with them, besides those in reserve.

This amount is understood to be in addition to that carried in the cartridge-boxes of the men, 60 rounds each in the case of an infantry soldier.

The wagons for this service are intended to carry 20,000 rounds each, and are drawn by four horses. Several wagons are organized into an equipment under the charge of a detachment of artillery; several such equipments would be attached to an army of 60,000 men, one for each division of infantry and a proper proportion for the cavalry; the remainder being in reserve.

The proportion given in the United States Ordnance Manual is 100 rounds for each man, 40 rounds in the cartridge-box, and the remainder in reserve for infantry.

Ammunition for cannon: 200 rounds for each piece, both of the reserves and active batteries; the ammunition which cannot be carried in the chests of the caissons to be kept with the reserves.

During our late civil war it is believed that, where at all practicable, the amount of readily accessible ammunition, both for artillery and small-arms, was kept largely in excess of the above standard.

A supply-train, under the charge of an ordnance-officer, was attached to each division, from which issues were made as required to the company or regimental officers, upon properly approved requisition.

The wagons of which these trains were composed were generally drawn by six horses or mules, and were capable of carrying from 40,000 to 60,000 rounds of small-arm cartridges, or an equal weight of artillery ammunition.

See Weapons; Projectiles.

Am'mu-ni'tion-chest. The box in which the fixed ammunition for field cannon is packed. One is carried on the limber of the gun-carriage, and one on the limber and two on the body of each caisson.

The chest is of walnut, and has a hinged lid, which is covered with sheet copper; it is fastened by means of a hasp and turnbuckle, and secured by a padlock.

The interior dimensions are 40 inches long, 18 inches wide, and $14\frac{3}{4}$ inches deep; and it is divided into compartments varying in number from 12 to 50, according to the caliber of the gun, by longitudinal and transverse partitions.

The shot, shell, case, and canister, with their cartridges, are inserted in these compartments, each in a separate part of the chest; and over these is fitted a tray for containing the fuses, friction-primers, and small implements required for the service of the piece.

The chest is fastened in position by means of *stay-pins* and *keys,* and is readily removed or replaced.

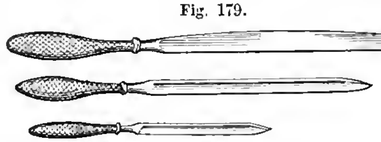
Am'phi-type. The amphitype process in photography is an application of the calotype process, taking its name from the fact of negative and positive pictures being produced by one process. It originated with Sir John Herschel. — *Photographic News.*

Am'pli-tude Com'pass. An azimuth compass whose zeros of graduation are at the east and west points, for the more ready reading of the amplitudes of celestial bodies.

Am-pul'la. Any vessel having a belly, as cucurbits, receivers, etc.

Am'pu-ta'ting-knife. A long, narrow-bladed knife used for making the incisions in amputations. The ancient surgeons endeavored to save a covering of skin for the stump by having it drawn upward previous to making the incision. In 1679, Lowdham,

Fig. 179.



Amputating-Knife.

of Exeter, England, suggested cutting semicircular flaps on one or both sides of a limb, so as to preserve a fleshy cushion to cover the end of the bone. Both these modes are now in use, and are called the "circular" and the "flap" operations. The latter is the more frequently used.

Amputation was not practised by the Greeks; at least, Hippocrates (B. C. 460) does not refer to it and did not practise it. Celsus notices it (A. D. 30). Cautery, pitch, etc. were used to arrest the bleeding. The needle and ligature were introduced about 1550, by the French surgeon Peré.

He was surgeon to Henry II., Francis II., Charles IX., and Henry III. of France, and though a Protestant was concealed in the king's chamber on the night of St. Bartholomew. The king is said to have remarked, "There is only one Peré." A complete set of surgical instruments of bronze was discovered at Pompeii. The tourniquet was invented by Morelli in 1674.

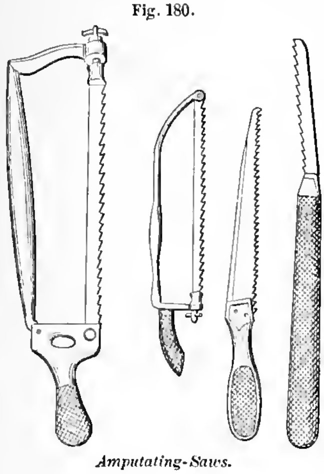
Basso-relievos in the temples of Karnak, Tentyra, and Luxor show that the ancient Egyptians performed amputations of limbs, without the tourniquet, however, or the mode of ligating the severed arteries ; it is merely a cutting and sawing, followed by the cautery, styptics, or compress.

The chirurgeon of ancient times was principally employed in reducing fractures and luxations, in treating wounds, applying topical remedies, and in the application of simple or strange drugs with occult charms and pow-wows.

One form of amputating-knife found at Pompeii in 1819 had a thick back and a wavy edge, and is supposed to have been used by the blow of a mallet on its back.

Am'pu-ta'ting-saw. Amputating-saws are modifications of the *tenon*, *frame*, *joint*, and *crown saws.* They are of sizes from 4 to 14 inches in length. Some have edges more or less curved, and the smallest of these dwindle down to a nearly circular plate of steel less than one inch in diameter, serrated round the edge, except where a slender shank terminating in a wooden handle is riveted to the edge of the saw-plate. These are known as Hey's saws, and are used in making exsections, operating on the cranium and metacarpal bones, and in removing carious bones from deep-seated places.

Fig. 180.



Amputating-Saws.

Am'u-sette'. A stocked gun mounted on a swivel, and carrying a ball or charge of buck-shot of from 8 to 32 ounces' weight.

An'a-bas'ses. (*Fabric.*) A coarse blanketing made in France for the African market.

An'a-clas'tic Glass. A sonorous, flat-bellied glass made in Germany, having a thin, flexible, slightly convex bottom, which is capable of flapping back and forth by the expiration or inspiration of the breath when the mouth is applied thereto. As the bottom is drawn in or out it makes a loud crash.

An'a-cos'ta. (*Fabric.*) A woolen diaper made in Holland for the Spanish market.

An æs-thet'ic Ap'pa-ra'tus. Anæsthesia is a term made use of in medicine to denote a deprivation of sensibility to external impressions, affecting a part or the whole of the body. In some nervous diseases a portion of the body may become partially or totally insensible to pain, while the sensibility of another part may become excessively acute, or in a state of hyperæsthesia. The division of a nerve, as is well known, produces an entire deprivation of sensibility in those parts of the body dependent on it.

When the insensibility is confined to the surface of the body it is termed *peripheral ;* but when arising from a cause acting on the brain or spinal marrow, from one or the other of which all the nerves emanate, it is called *central.*

Means for inducing temporarily either of these conditions with safety to the patient have been long sought for in surgical practice. The Indian hemp, *Cannabis Indica*, was anciently employed ; and it appears that the Chinese employed some preparation of hemp for producing insensibility during surgical operations, more than fifteen hundred years ago. Mandragora was used by the Greeks and Romans for the same purpose, and appears to have continued in use, in combination with opium and other drugs, so late as the thirteenth century, the patient inhaling the vapor from a sponge saturated with these substances. The mandragora, however, at times induced convulsions, and though mention is made of its anæsthetic powers for producing a "trance or a deepe terrible dreame," in operations for the stone, toward the close of the sixteenth century, it, or similar agents, appears to have gradually gone out of use.

It seems a little singular that sulphuric ether should not have been employed for the purpose for some three centuries, unless, as has been suggested, it is the substance spoken of by John Baptista Porta of Naples, who published a book on Natural Magic in 1597 ; this "quintessence" was extracted from medicines by somniferous "menstrua," and was kept in leaden vessels tightly closed to prevent its escape. The cover being removed, it was applied to the nostrils of the sleeper, who was thereupon thrown into the most profound sleep, etc., etc.

In 1784, Dr. Moore of London tried the expedient of compressing the nerves of a limb preparatory to amputation ; but this caused much pain.

Narcotic poisons will induce anæsthetic conditions of the body, in which surgical operations may be performed without apparent pain to the subject. The same is true of alcohol. The peculiar nervous condition induced by what is called animal magnetism has also produced insensibility to pain, during which operations have been performed.

The modern anæsthetic agents are : cold applications, protoxide of nitrogen (laughing-gas), chloroform, ether, amylene, kerosolene.

Sir Humphry Davy suggested the use of protoxide of nitrogen as an anæsthetic agent in surgical operations. It was used by Dr. Wells of Hartford, Conn., in 1844, in dental operations. It has now attained great favor.

Chloroform is a terchloride of formyle (the hypothetical radical of formic acid). Its discovery is claimed by Soubeiran, Guthrie, and Liebig, whose claims have about an even date, 1831. The verdict seems to have settled in favor of the former. Its first use as an anæsthetic was by Dr. Simpson of Edinburgh, 1847.

Hydrate of chloral has recently become quite unpleasantly prominent in the list of anodynes, sedatives, and hypnotics.

Ether was known to the earliest chemists. The discovery of its use as an anæsthetic was made by Dr. Jackson or Dr. Morton of Boston, in 1846. A contest ensued between the parties to prove priority, and was much debated in the scientific journals of the day. In an application to Congress for a remunerative appropriation of $100,000, the representatives of Dr. Wells came in with a claim to the first invention. The enterprise failed, but mankind owes a debt of gratitude to each.

Amylene is a colorless liquid obtained by distilling fusel oil with chloride of zinc. It was discovered by M. Balard, of Paris, in 1844. First used by Dr. Snow in 1856.

Kerosolene was derived from the distillation of coal-tar by Merrill of Boston. Its use as an anæsthetic was made known in 1861.

Nitrate of ethyl, of which the chemical formula is $C_4 H_5 O, No_5$ possesses remarkable anæsthetic properties; it has a very fragrant and agreeable smell, a sweet, but a bitter after taste. Its boiling-point lies at 185° Fahr., and its specific gravity is 1.112 at 62.5° Fahr. It burns with a white flame, is not soluble in water, but easily so in alcohol.

Various forms of apparatus are used in the administration of anæsthetic agents. Some consist of cups which contain the sponge saturated with the liquid and exposed to the current of air as it passes to the lungs. Others pass the air through a body of liquid. The administration of nitrous-oxide requires a different arrangement, and the tube connecting the bladder with the mouth-piece has valves so arranged as to pass the gas to the mouth during inspiration, and allow the expired breath to pass to the atmosphere instead of contaminating and weakening the contents of the bag.

These are more properly considered under INHALERS (which see), as that has become the term by which they are generally known and patented. A class of inventions which preceded the inhalers just described are termed RESPIRATORS (which see), and are not adapted for the introduction of anæsthetic or curative medicaments into the lungs, but are intended as air-heaters or filters, and are used by two classes of persons, — by consumptives to temper the rigor of the air in cold weather, by causing the air to rush rapidly through a succession of narrow passages; and by mechanics, cutlers especially, to arrest particles of steel and grit which permeate the air where the grinding is carried on.

The anæsthetic apparatus which operates by topical application of cold is ordinarily in the form of an ATOMIZER (which see), and consists of a tube whose lower end communicates with a body of liquid, and whose contracted upper end is exposed to a blast at right angles to the axis of the upper tube and across the orifice thereof. This has the effect of raising the liquid, which is dispersed as it reaches the opening, and, assuming the form of fine spray, becomes a great absorber of sensible heat, and consequently lowers the temperature of the air in its vicinity. The air, thus cooled, is projected upon the part where local anæsthesia is required, and by absorbing the heat of the part renders the nervous system of the part incapable of feeling, calloused by cold.

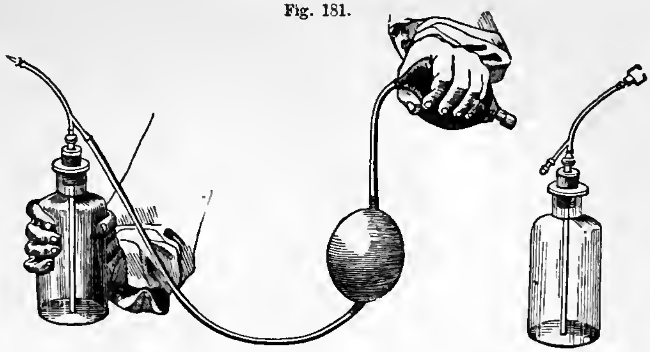
Bags of ice have been laid upon the part affected to produce insensibility by freezing.

For freezing mixtures, see ICE, MANUFACTURE OF.

An'æs-thet'ic Re-frig'er-a'tor. An apparatus for producing local anæsthesia by the application of narcotic spray.

The apparatus consists of a bottle to contain the ether or other fluid to be used; through a perforated cork a double tube is passed, one extremity of the inner part of which goes to the bottom of the bottle; above the cork a tube, connected with the bellows, pierces the outer part of the double tube, and communicates by a small aperture at the inner end of the cork with the interior of the bottle. The inner tube for delivering the ether runs upward to the extremity of the outer tube.

Fig. 181.



White's Anæsthetic Refrigerator.

When the bellows are worked, a *double current of air is produced;* one current descending and pressing upon the ether, forcing it along the inner tube, and the other ascending through the outer tube and playing upon the column of ether as it passes from the inner tube.

Put the ether into the bottle, nearly filling it, then insert the tube with the cork firmly, and fit the nozzle to give the jet desired; the bulb on the extremity of the rubber-tubing, being now grasped in the hand and rapidly used as a hand-bellows, — the other bulb acting as a reservoir, — keeps up a steady pressure upon the ether and produces a continuous j t.

The small wires, called stylets, are used to graduate the spray, which is made finer or heavier by the use of the different sizes.

Remove the nozzle and insert the stylet in the small tube. The hook on one end of the wires is to prevent their slipping into the tube.

Two nozzles accompany the instrument; the straight one for producing a single jet, and the double curved one for operating on both sides of a molar tooth.

An'a-glyph. A chased or embossed ornament.

An'a-glyp'to-graph. An instrument for making a medallion engraving of an object in relief, such as a medal or cameo. A point is passed over the medal at an angle of 45°, and communicates motion to a diamond etching-point. The diamond partakes of the motions of the tracer, following the curves of the object, making the lines relatively open on the sides of the protuberances upon which the light is supposed to strike, and making the lines closer on the sides opposed to the light. See MEDALLIC ENGRAVING.

A'nal-di-la'tor. (*Surgical.*) An instrument for dilating the sphincter muscle for the examination of hemorrhoids or fistula in ano.

An'a-lem'ma. A form of sun-dial now disused.

A'nal-spec'ulum. (*Surgical.*) An instrument for distending the anal opening to expose the inner surface of the rectum, in case of hemorrhoids, fistula in ano, etc. See SPECULUM.

An'a-lyz'er. The upper or eye prism of the polarizing apparatus.

The first of the two columns in the Coffey Still; the second being the rectifier. See STILL.

An'a-plas'tic In'stru-ment. For the operation of forming a nose upon the face. The Tagliacozzian operation. See RHINOPLASTIC PIN.

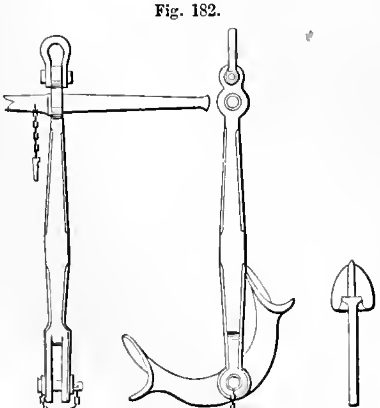
An a-stat'ic En-grav'ing and Print'ing. Invented by Wood in 1841. An engraving or other printed sheet is moistened with dilute phosphoric acid, and pressed on to a clean surface of zinc, which is etched thereby in the place not protected by the ink. The plate is kept damp by acidulous solution of gum, and in the printing process only takes ink from the rollers at the points where the ink of the original impression first adhered.

Zincography is the term applied to drawing upon zinc for subsequent treatment as above.

An'chor. 1. Anchors were, according to Apollonius Rhodius and Stephen of Byzantium, originally made of stone, or of logs of wood covered with lead. These were succeeded by a bent rod with a single fluke. The invention was ascribed by Pliny to the Tuscans; Strabo ascribes the addition of the second fluke to Anacharsis the Scythian. They were first forged in England, A. D. 578, when Titillus reigned in East Anglia. The general shape of anchors is well known, consisting of two arms terminating in broad expansions termed flukes, and attached to a long shank, to which is fixed a stock of wood or iron at right angles to the arms, to insure the perpendicularity of the flukes when the anchor is on the bottom, in order that they may take firm hold of the ground. Small anchors termed grapnels, and having four or more arms, are used for boats, and at times for small vessels. The mushroom-anchor, so called from its shape, is much employed in the East Indies by the native vessels called grabs. The weight of the largest anchors, for vessels of 1,000 tons or less, is about 1 cwt. for each 20 tons measurement, or .0025 of the tonnage. Various improvements have been proposed upon the ordinary anchor, of which the most prominent are Rodgers's, Trotman's, and its modifications, Isaacs's and Lenox's.

In TROTMAN'S anchor the arms are passed through the shank, which is slotted, and are held by a bolt, thus bringing the upper arm and fluke down on the shank, and allowing the lower one to penetrate deeper when the anchor is on the bottom.

Fig. 182.



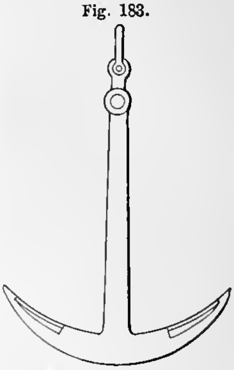
Trotman's Anchor.

This arrangement, aided by the horns on the back of the flukes, also prevents fouling. At a trial made in 1853, under the auspices of the British Board of Admiralty, to determine the comparative general merits of various descriptions of anchors, their comparative merits were decided to be as follows, the Admiralty anchor being taken as unity: —

Trotman	1.28	Honibal (or Porter)	1.09
Rodgers	1.26	Aylen	1.09
Mitcheson	1.20	Admiralty	1.00
Lenox	1.13	Isaacs	.73

Notwithstanding the numerous recent modifications claiming to be improvements, an anchor differing little from the old-fashioned type, excepting that even the very largest sizes have iron stocks, still maintains its place both in the navy and merchant service of the United States.

Fig. 183.

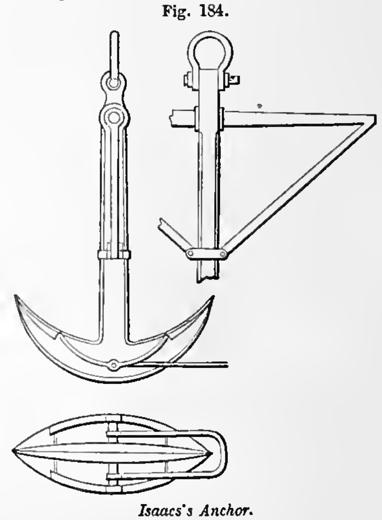


English Admiralty Anchor.

Anchors require to be made of the very best and toughest wrought-iron. They are made by welding together a fagot of bars under a steam or trip hammer, the smaller and more difficult portions being shaped and rounded off, and the whole anchor finished up by hand. This portion of the work, especially in the case of a large anchor, is one of the most arduous labors of the smith's shop; as the workmen are unable to stand the intense heat from the huge mass of red-hot metal and wield the ponderous sledge-hammers employed but for a very short space of time, each strikes his blow and falls back to make room for another, who in turn retires to give place again to his predecessor, and so on until the iron becomes too cool for further hammering. This evidently requires a considerable share of strength, activity, and endurance on the part of the men, who are not only compelled to strike while the iron is hot, but have to put in as many and as heavy strokes as they possibly can in the time.

ISAACS'S anchor has a flat bar of iron from palm to palm, which passes the shank elliptically on each side, and from each end of the stock to the mid-length of the shank are fixed two other bars to prevent fouling.

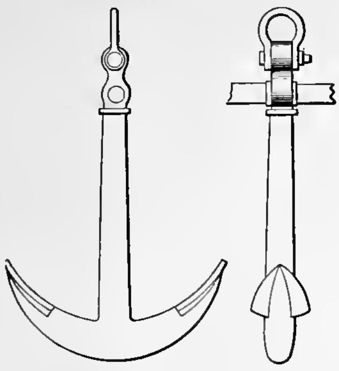
Fig. 184.



Isaacs's Anchor.

PORTER's anchor, or HONIBAL's as it is sometimes called from the purchaser of the right, is very similar to Trotman's (which see), the latter being an improvement upon Porter's, with some

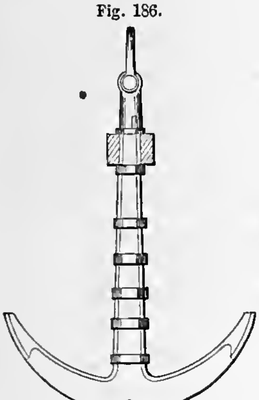
Fig. 185.



Lenox's Anchor.

modifications in the shape of the flukes and their horns. LENOX's improvement (1832–39) consisted in an improved mode of welding, and in rounding off the sharp edges and lines; also in reducing the size of the palms, the object being to obtain a stronger anchor and prevent injury to the cable.

Fig. 186.

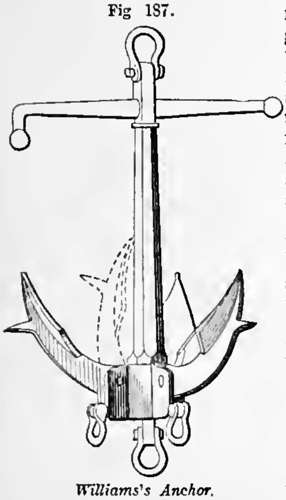


Rodgers's Anchor.

RODGERS's anchor has a shank with a wooden core, for giving more surface, and consequent strength for a given weight of metal.

WILLIAMS's anchor, patented March 16, 1858. This anchor has three flukes hinged to a block at the lower end of the shank, and so set that two of them may penetrate the ground at the same time, while the third falls down upon the shank to prevent the cable from being fouled. The flukes are set at 120° apart and hinged in a separate block.

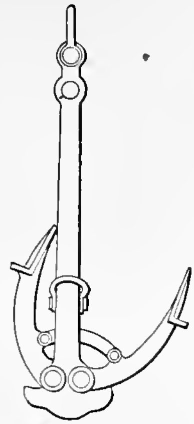
Fig 187.



Williams's Anchor.

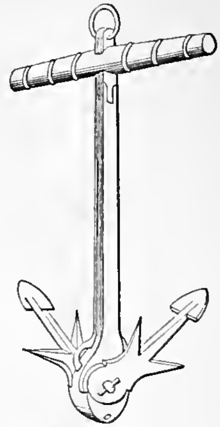
MORGAN's anchor, patented June 21, 1864. The arms are separately pivoted near the end of the shank, and are connected by a curved bar passing through a hole in the shank. When one fluke has hold of the ground its arm rests against and is supported by the crown-piece, while the other arm falls down upon the shank, obviating the danger of fouling and by means of the curved bar assisting the first arm to bear the strain.

Fig. 188.



Morgan's Anchor.

Fig. 189.



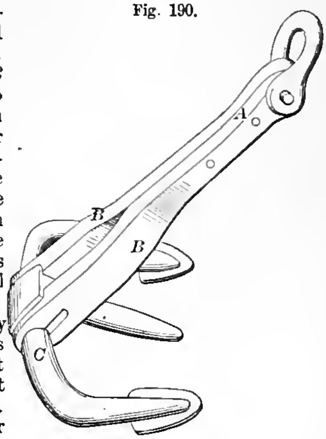
Marshall's Anchor.

MARSHALL's anchor, patented October 17, 1865. Antedated March 6, 1865.

The arms are straight and turn in an arc of a circle, moving separately on a pivot passing through the crown. Each is provided with barbs or projections to help the fluke to take and retain its hold, and the oscillation is checked by cusps on the thick portion of the crown, so that the arms have a given inclination to the shank.

LATHAM's anchor, patented August 21, 1866. The shank *A B* is made of two pieces, which separate at their lower ends to allow the passage of the middle fluke. The arm *C* turns in the shank and has three parallel flukes.

Fig. 190.



Latham's Anchor.

The weight by these means is concentrated at the lower part of the anchor. When the anchor is let go, the flukes make about a quarter of a revolution, lying in the position shown in the illustration when they enter the ground. The shoulder on the crown-piece comes against the shank and restrains the oscillation of the arms in either direction, and the anchor stows compactly by bringing the arms parallel with the shank, the middle arm or fluke lying in the space between the two portions of the shank.

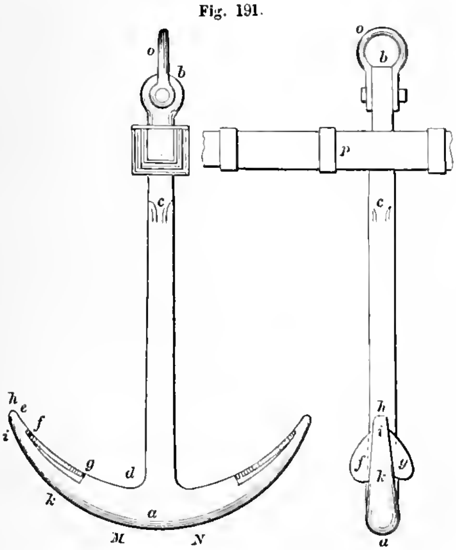
STUARD's anchor. Among the single-armed anchors may be mentioned Stuard's (English), which has a very short shank made in one piece with the arm, the pile being bent, but not welded. The stock is a wrought-iron bar with knobs on the end, which cant the anchor so that its fluke penetrates the ground as it is dragged along. One hole in the shank is for attachment of the cable, and a shackle at the crown is for the buoy-rope.

The largest anchor in the world, according to Charles Ryland's "Iron Trade Report," was made at H. P. Parke's Works, Tipton, Staffordshire, for the Great Eastern, and weighs eight tons exclusive of the stock. Its dimensions are: Length of shank, twenty feet six inches; of wood-stock, nineteen feet six inches; trend of arms, seven feet four inches. It is somewhat different in form from ordinary anchors, the palms or blades being divided or split so that it may more readily pierce the sea-bottom.

The parts of an anchor are as follows: —

a to *b*, shank; *b* to *c*, square; *d* to *e*, arm; *f* to *g*, palm, fluke, or kevel; *h* to *i*, point, pee, or bill; *i* to *k*, blade; *M* to *N*, crown; *o*, ring; *p*, stock; *d*, throat or crutch.

Fig. 191.



Anchor.

For checking and regulating the motion of the cable as it runs towards the *hawse-holes* while the anchor is dropping, and for holding the cable after the anchor has taken hold, four kinds of apparatus are used together or separately, — CONTROLLERS, BITTS, STOPPERS, COMPRESSORS (which see).

To *cast* or *drop* anchor is to let go the anchor.

To *ride* at anchor is the condition of the vessel when anchored.

To *swing* at anchor is when the ship obeys the change in the direction of the tide while at anchor.

To *weigh* anchor is to heave it out of the ground.

To *back* an anchor is to strengthen its hold of the ground by means of a second anchor laid down ahead of the other, and fastened to the crown of the latter by a cable.

An anchor is *foul* when the cable is twisted around it or the anchor is entangled with a wreck or another anchor.

The anchor *bites* when the fluke takes hold of the ground.

To *sweep* for an anchor is for the recovery of a lost anchor by sweeping the bottom with the bight of a cable or hawser.

Parting: Breaking cable and leaving the anchor in the ground.

An anchor is *a-cock-bill* when it is suspended perpendicularly from the cathead ready to let go.

It *comes home* when dragged from its hold by the pulling of the cable.

An anchor is *a-stay* when the angle of the cable with the water is about that of a stay. A *long-stay* apeak when coinciding with the *main* stay; *short* stay when with the *fore* stay.

It is *a-peak* when the cable is drawn in so tight as to bring the ship directly over it.

It is *a-weigh*, or *a-trip*, when lifted clear of the ground.

It is *a-wash* when lifted to the surface of the water.

It is *hove up* when lifted to the hawse-hole.

It is *hooked* when cat-fall is fast to the ring.

It is *catted* or *hauled up* when lifted by the ring to the cathead.

It is *fished* when the fluke next to the ship's side is lifted to the fish-davit.

It is *on-board* when the fluke is lifted to its resting-place on the bill-board.

It is *in-board* when on deck.

It is *secured* when all is made fast, the cable and buoy-rope *unbent*, and the anchor *stowed*.

The *weight of Anchor and Kedge* is given exclusive of that of its stock.

Bower and Sheet Anchors should be alike in weight.

Stream Anchors should be ¼ the weight of the best bower.

Kedges are light anchors used in warping.

2. The block, frame, or masonry deeply buried in the earth, to which the cables or wires of suspension-bridges are attached. See ANCHOR, SUSPENSION-CABLE.

An'chor and Col'lar. A form of hinge for a lock-gate. The *anchor* is let into the stone coping; the collar is attached like a clevis to the anchor, and forms a socket for the pintle of the heel-post of the gate.

An'chor-ball. 1. A contrivance of Captain Manby, R. N., for saving life in cases of shipwreck. It is a ball having several hinged prongs fitting in slots, which are intended to catch in the rigging of a stranded vessel.

It is fired from a mortar, and carries a light line by which a stout rope may be carried ashore from the vessel.

The French use a ball for this purpose having a harpoon passing through it, on the rear end of which a line is wound.

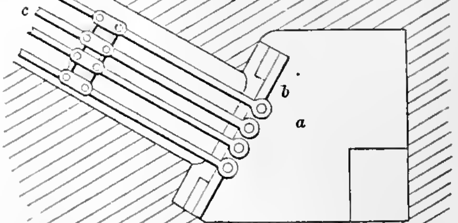
2. A carcass or incendiary ball affixed to a grapnel by which it is intended to adhere to and fire a vessel.

An'chor-bolt. (*Machinery.*) One having an expanded shank to prevent its drawing out.

An'chor-chocks. Blocks on which a *stowed* anchor rests.

An'chor, Sus-pen'sion-ca'ble. The anchors of

Fig. 192.



Suspension-Chain Anchor.

the chains of the Menai Suspension Bridge are cast-iron plates having a bearing against the solid rock. Three oblique circular shafts six feet in diameter and sixty feet in depth were blasted into the solid rock, a considerable space being left between each shaft. At the bottom is a cross-tunnel which runs horizontally and at right angles to the inclined shafts. The iron plates, weighing 2,240 pounds, were fitted into seats in the face of the rock at right angles to the chains which are bolted thereto. *a*, cross-tunnel; *b*, anchor; *c*, suspension-cable.

An'chor-drag. See DRAG-ANCHOR.

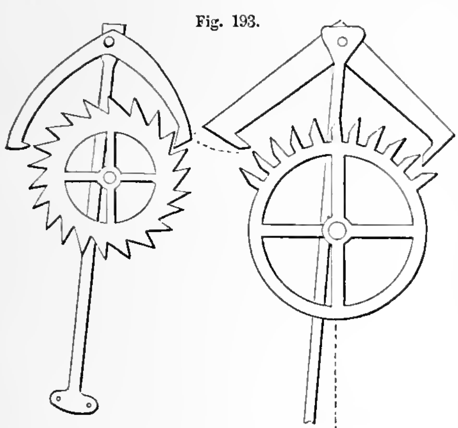
An'chor Es-cape'ment. The anchor escapement superseded the crown-wheel escapement for clocks. It was invented by Clement, a London watchmaker, in 1680. By some it is credited to Dr. Hooke.

The anchor has two arms whose bent ends resemble flukes in some degree, and thus give rise to the name. It is suspended from a horizontal axis, on which it turns freely along with the dependent stem, which terminates at its lower end in a fork or crutch between whose prongs the pendulum-rod passes, so that the motions of the pendulum are communicated to the anchor, and the pressure of the wheel upon the pallets of the anchor is also communicated to the pendulum so as to make up for the small loss by friction incident to its action.

"The great advantage of this escapement over the old crown-wheel is that it allows the escape to take place at a small angle of vibration, thereby preventing the necessity for the maintaining power acting upon the pendulum with so great force as by the old plan; and by the introduction of a heavy ball, leaving that to be done by the uniform power of gravity which before was dependent upon the impulse given by the wheel to the pallets."

Clement, in connection with this escapement, introduced his mode of suspending the pendulum by a thin piece of flexible spring, a mode which has remained in favor ever since.

Fig. 193.



Recoil. Dead beat.

Anchor Escapement.

Figure 193 shows two forms of anchor escapement: one is on the *recoil* principle and the other is the *dead-beat*; the former is so called because each tooth of the wheel makes a back or recoil motion after escaping from the pallet. In the figure one tooth is represented as having just escaped from the anchor, and a tooth on the opposite side of the wheel has dropped on to the pallet. The pendulum continuing its course a little farther to the left, the slope of the pallet will drive the tooth on the right a little way back and produce the recoil.

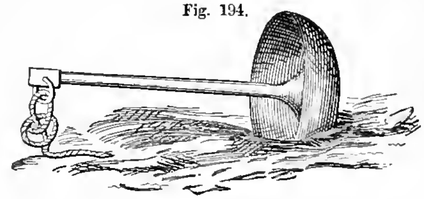
The other figure shows the *dead-beat* escapement, in which the slope of each pallet stops at the points where the teeth fall, the rest of each pallet forming portions of a circle of which the axis is the center. The tooth having passed the pallet, the continued motion of the pendulum merely holds the tooth, but does not give it any backward motion. See DEAD-BEAT ESCAPEMENT; RECOIL ESCAPEMENT.

An'chor-gate. A heavy gate, such as is used in the locks of canals, requires for its upper bearing a collar which is stayed by the adjacent masonry. Barbed metallic projections from the collar are embedded in the masonry, and resist displacement of the gate while enduring strain or swinging on its axis.

An'chor-lin'ing. Sheathing on the ship's planking, under the fore-channels, to keep the bill of the anchor from ripping the ship's side when hauling it up, or *fishing*.

An'chor, Mush'room. The *mushroom anchor* is used for moorings, and is said to be a favorite in the East Indies. Its name indicates its form, having a central shank and a head of a bowl shape, which requires no *stock* on the *shank* to cause it to engage with the ground over which it is dragged.

Fig. 194.



Mushroom Anchor.

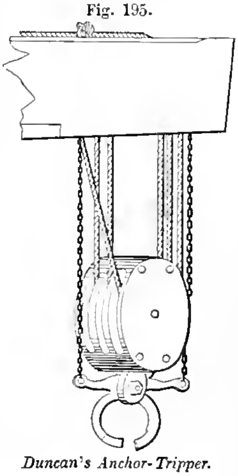
An'chor-ring. The ring of an anchor by which it is bent to the cable. A jew's-harp shackle is now used.

An'chor-stock Plank'ing. (*Ship-building.*) Each plank has one straight edge, the other consisting of two equal slopes.

An'chor-trip'pers. These are devices for "tripping" or casting loose a ship's anchor. In some of them it is suspended by its ring from the cat-block or a tripping-bolt; in others it is fastened at each end by chains which are cast loose simultaneously.

DUNCAN, April 28, 1863. The anchor hangs from a clutch-ring on the cat-block, which is suspended below the cat-head. When the fall is cast loose, the block descends, and the clutch is opened by the chains which are attached to the cathead, and to the projecting levers or prongs on the respective halves of the clutch. A single motion, the slackening of the fall, operates the tripper; the clutch is opened when the chains are made taut by the descent of the block.

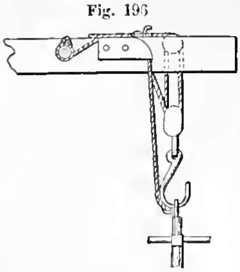
Fig. 195.



Duncan's Anchor-Tripper.

STACEY, December 27, 1864. The anchor is suspended by its ring from

Fig. 196

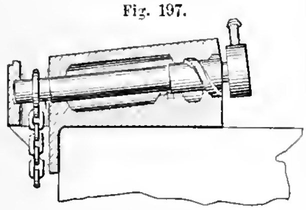


Stacey's Anchor-Tripper.

the hook of the fall-block, which depends from the cat-head. The tripping-rope is attached to an eye on the fall-block hook, and is belayed to a pin on the cat-head. When the fall is cast loose, and as soon as the slack of the tripping-rope is exhausted, the said rope upsets the hook, and casts loose the anchor.

HOLMES, April 28, 1857. A short chain is attached to the ring of the anchor, and the link on its upper end is transfixed by a pin which has its bearings in a block. By turning the handle half a revolution in one direction, the screw upon the shaft will cause the pin to recede, and disengage itself from the link of the chain. The thread works in a spiral groove or nut, by which it receives longitudinal motion when partially rotated.

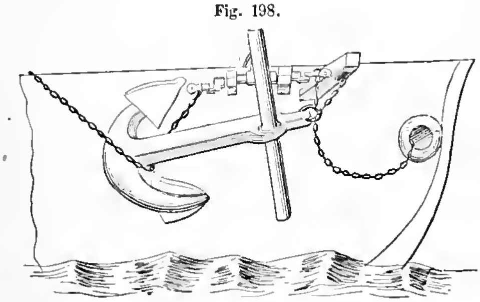
Fig. 197.



Holmes's Anchor-Tripper.

HEITMAN, May 16, 1865. The anchor is suspended by a shank-painter and a ring-stopper. One end of each chain is fast to the vessel, while the ring at its other end rests upon a pivoted latch-piece. These latch-pieces are supported upon a bar, which is rotated to give simultaneous disengagement to the latches, and cast the anchor loose. The movement of the bar is effected by raising a lever which rests upon the rail.

Fig. 198.

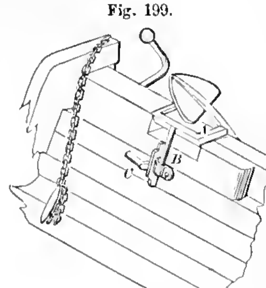


Heitman's Anchor-Tripper.

There are thirteen United States patents for anchor-trippers.

GIBSON, December 5, 1865. In this device the fluke of the anchor rests on a block *A*, which is pivoted in a notch of the gunwale. A bar *B*, attached to said block, is held by a shackle-bar *C*, when the latter is in its upper position. By sliding the shackle in its staple, the bar is released, and the block *A* freed to rotate under the weight of the anchor, which is thereby "tripped."

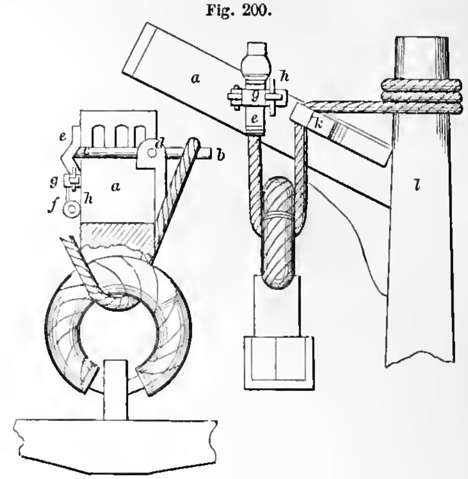
Fig. 199.



Gibson's Anchor-Tripper.

BURTON'S anchor-tripper (English). The standing end of the cat-head stopper is worked into a ring placed around the end of the bolt *b c*, which is pivoted at *d*, on the cat-head *a*. The other end *c* of the bolt is oblique, and is held down by the clamp *e*, turning on the pivot *f*, the clasp being secured by a hasp *g*, and pin *h*. The cat-head stopper passes through the ring of the anchor, over the thumb-cleat *k*, and is made fast round the timber-head *l*. When it is required to let go the anchor, a handspike is inserted, so as to bear against the clasp *e*, and hold it closed while the pin *h* is withdrawn, and the hasp *g* is cast off. The handspike being then removed, the oblique end *c* of the bolt throws open the clamp *e*, and the bolt revolving on its pivot *d* allows the standing end of the cat-head stopper to fall off, and the anchor to drop.

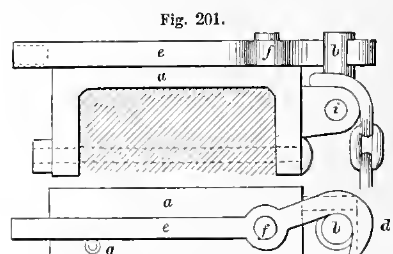
Fig. 200.



Burton's Anchor-Tripper.

SPENCE'S tripper (English) is especially intended for casting off the *shank-painter*, which holds the *shank* and *flukes* to the ship's side, while the *cat-head stopper* holds the *ring* of the *stock*.

Fig. 201.

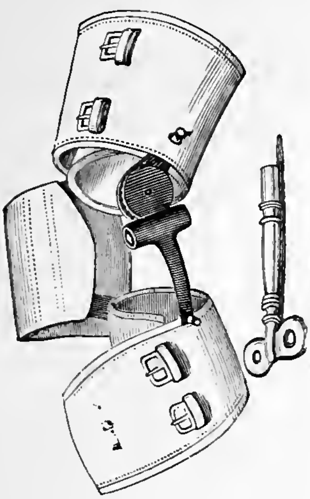


Spence's Anchor-Tripper.

a is a carriage bolted to the gunwale; *b* is a bolt which is pivoted at *i* to the carriage, and sustains the chain-end of the *shank-painter*; *c* is a lever pivoted at *f* to the upper side of the carriage *a*, and having a hook *d* at its end which holds the bolt *b* in an upright position. When the *shank-painter* is to be cast off, a pry is taken upon the end of the lever by a handspike till the pin *g* is removed. The lever *e* is then oscillated till the hook *d* is disengaged from the bolt *b*. The latter is immediately rotated by the weight of the anchor, and the shank-painter is cast loose.

Anch'y-lo'sis Ap'pa-ra'tus. An apparatus for relieving the strain upon the flexed anchylosis articulation by supporting the respective parts of the limb at a distance from the center of leverage.

Fig. 202.



Anchylosis Apparatus.

Fig. 202 shows an apparatus adapted for the knee. The upper and lower bands are secured around the thigh and lower leg respectively, the joint being set immovably at the angle required. The small figure represents the key by which the joint is loosened or locked.

Ancon; Ancone. An elbow or angle. *Aquoin.* An ornamental keystone. A *console.* The angle of a knee-tumbler.

An'co-ny. (*Metal-working.*) A piece of partially wrought bar-iron, partly finished in the middle, but unwrought at the ends.

An'cove. (*Architecture.*) A console on each side of a door to support a cornice or entablature.

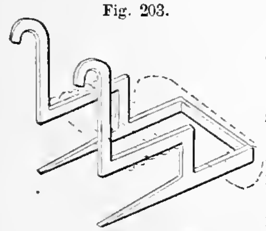
An-cy'lo-mele. A curved probe used by surgeons.

And'i-rons. These are used upon the hearth to support the burning logs and brands. Sometimes called dog-irons, and familiar to all who have been acquainted with the old-fashioned fireplace.

Smylie, July 12, 1843. The horses of the andirons are adjustably connected, so as to place them at any convenient distance apart and keep them steady. They are guarded by a safety-bar against the danger of upsetting.

Logan, March 27, 1860, has a bottom plate or frame, in combination with two upright angular bars, in such a manner that the same stands firmly in its place and allows a free circulation of the heat.

Fig. 203.



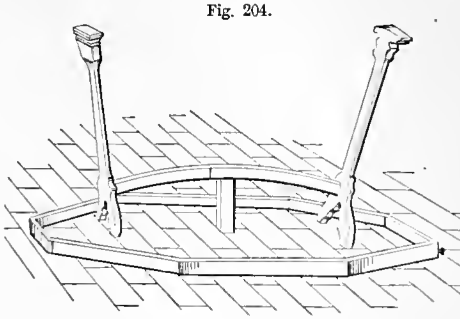
Logan's Andiron.

The name *andiron* is supposed to be derived from the Anglo-Saxon *brand-iron.* Others derive it from *hand-iron.*

For the large kitchen fire, the andirons were very strong and massive, but usually quite plain. In the hall, that ancient seat of hospitality, they were also strong and massive, to support the weight of the huge logs; but the standards were kept bright or ornamented with brass rings, knobs, rosettes, heads and feet of animals, and various grotesque forms. In kitchens, and in the rooms of common houses, the andiron, as its name implies, was of iron; but in the hall the standards were of copper or brass, and sometimes of silver.

Until the seventeenth century wood was the ordinary fuel. It was burned in holes dug in the floor, on hearths in the middle of the floor or against the wall. Chimneys are a comparatively modern invention, and no traces of them are found previous to the twelfth century. See Chimney.

Fig. 204.



Andiron.

In the baronial halls of England the logs were liberally piled on the hearth in the middle of the hall, being confined within the two standards of the *andiron*, their ends resting on the billet-bar for the purpose of admitting air beneath them, and thus promoting combustion.

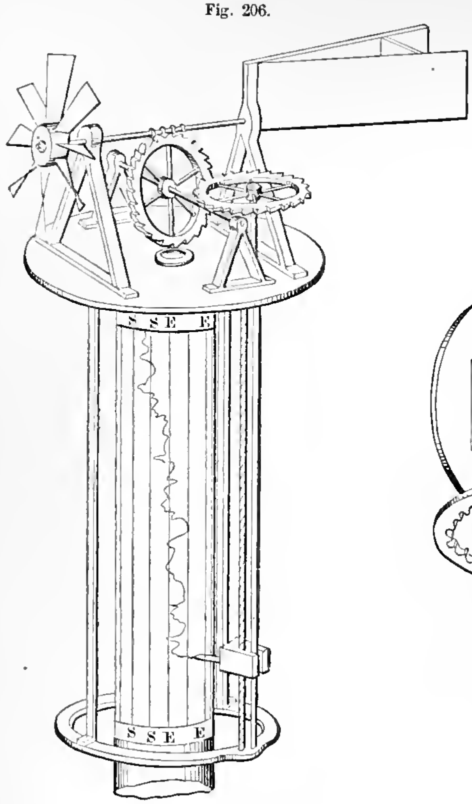
A-nem'o-graph. An instrument for measuring and recording the direction and force of the wind.

An'e-mom'e-ter. An instrument for determining the force of the wind. The most simple form of this instrument is a board or other plane surface of given area, which is presented to the wind and has a spring attached by which the direct force of the wind is measured on a principle precisely similar to that of an ordinary spring-balance. A scale may be attached, which will show the absolute pressure in pounds and fractions to the square foot or inch. The earliest known anemometer was that of Dr. Crombie, 1667, afterwards improved by Wolfius and others. Dr. James Lind of Windsor invented, about the year 1775, a very convenient and accurate anemometer which is well suited for private observers or those desiring a portable instrument occupying a small space. It consists of a graduated glass tube having two arms, one of which has the upper part bent perpendicularly; the tube is mounted on a stand, the two arms being in a vertical position, and the bent portion horizontal, so that its mouth can be presented to the wind. Water is poured in until the instrument is filled to the middle or zero of the scale. For use, it is placed so that the mouth shall receive the full force of the wind, which depresses the water in that arm and causes it to rise in the other. As the pressure of the atmosphere at the earth's surface will ordinarily sustain a column of water about 33 feet in height, which is equivalent to about 2,060 pounds to the square foot, if we suppose the wind to blow with a force sufficient to cause a difference of level of one inch in the two branches of the tube, this

Fig. 205.

Lind's Anemometer.

Fig. 206.



Whewell's Anemometer.

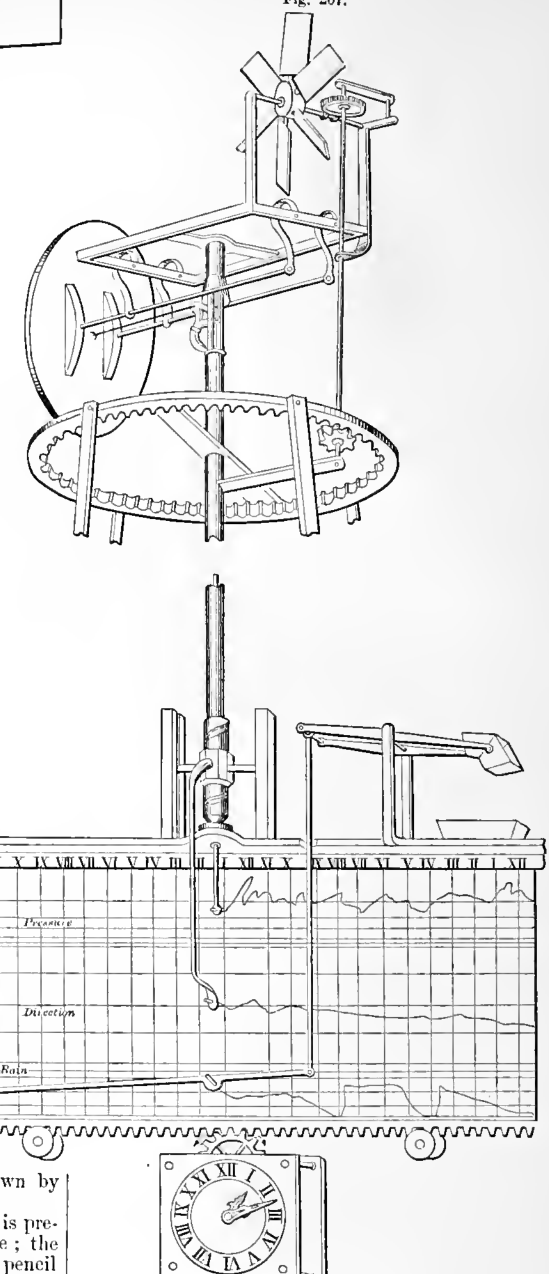
indicates a pressure equivalent to $\frac{1}{12}$ of $\frac{1}{33}$ of the whole weight of the atmosphere, or about $5\frac{2}{10}$ pounds to the square inch. The force being as the square of the velocity, the latter is readily ascertained by calculation, or by inspection from a table engraved on the instrument.

Another form of anemometer is operated by vanes like the sails of a windmill and working on the same principle; their axis has a perpetual screw which turns a vertical cog-wheel on an axis at right angles to the axis of the vanes. To this is attached a bar connected to a counterpoise weight sustained by a cord passing around a cone. The movement of this bar, actuated by the vanes, indicates the comparative force of the wind, which is shown by the dial.

In WHEWELL's anemometer a windmill fly is presented perpendicularly to the wind by a vane; the fly actuates a train of gearing which causes a pencil to descend, according to the force of the wind and consequent velocity of revolution of the fly, and trace a corresponding line on a fixed cylinder, which is divided by vertical lines representing the points of the compass; as the wind changes, the pencil is moved round on the surface of the cylinder, and caused to register the direction as well as the velocity of the wind, the former by its rotary and the latter by its vertical motion.

Mr. OSTLER's apparatus, or some modification of it, is probably the most perfect yet devised, especially

Fig. 207.

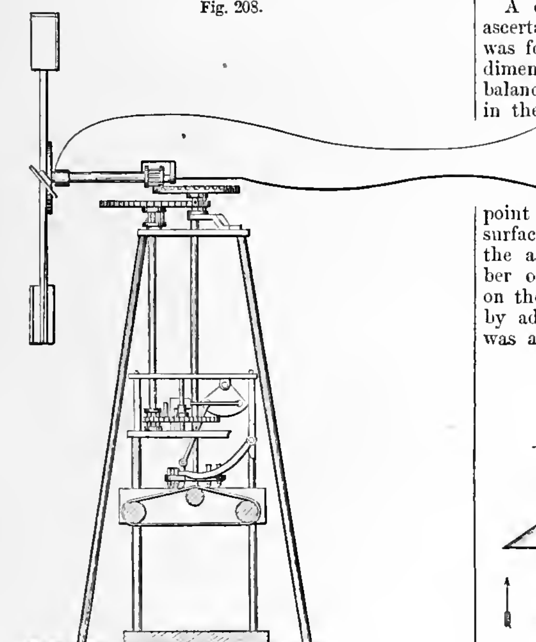


Ostler's Anemometer.

for public institutions, or where it is desired to keep a perfect record of the changes in the force and velocity of the wind. The essential parts are a plate, having its face constantly presented to the wind by a set of vanes at right angles to it; the force of the wind on this plate causes it to move an arm carrying a pencil, which makes a mark on a sheet of paper especially ruled for the purpose, having separate compartments for registering the force and direction of the wind, and a third to show the amount of rain; the paper is slowly moved forward by clock-work; the pencil approaches toward or diverges from the edge of the paper as the force of the wind varies, while a similar pencil, attached to an arm connected by a spiral worm and nut to the guide-vanes above mentioned, registers the direction of the wind in the center compartment. The rain-gage is attached to a bent lever, also carrying a pencil, which is drawn toward the center of the paper as the gage becomes filled with water, thus indicating the amount of rain. When the gage is completely full it tilts, empties itself, and the record commences afresh.

STUNTZ, February 4, 1862. An endless apron moving upon three rollers carries the paper upon which the record is to be made, a uniform velocity being given to one of the rollers by clock-work. A pencil-holder is attached to the lower part of the vane-shaft, and the proper mark is made on the highest part of the apron above the roller. A pricker, actuated by a spring through mechanism operated by a wind-wheel, makes perforations in the paper, the number occurring in a given length denoting the velocity of the wind during the intervals of time indicated by a scale on the paper.

Fig. 208.



Stuntz's Anemometer.

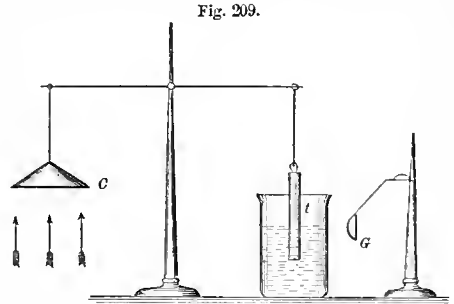
The following table, calculated by Smeaton, shows the force and velocity of the wind: —

Velocity per hour. Miles.	Per second. ft	Pressure per sq. ft. lbs.	
1	1.47	005	Hardly perceptible.
2	2.93	.020	Just perceptible.
3	4.40	.044	
4	5.87	.079	Gentle, pleasant wind.
5	7.33	.123	
10	14.67	.492	Pleasant, brisk breeze.
15	22.00	1.107	
20	29.34	1.968	Very brisk.
25	36.67	3.075	
30	44.01	4.429	High wind.
35	51.34	6.027	
40	58.68	7.873	Very high.
45	66.01	9.963	
50	73.35	12.300	A storm or tempest.
60	88.02	17.715	A great storm.
80	117.36	31.490	A hurricane.
100	146.70	49.200	A hurricane that tears up trees, carries buildings, etc. before it.

About twenty varieties of anemometers are described in works devoted to physics, under the department Meteorology.

A convenient form of anemometer, adapted for ascertaining the force of currents in pipes or flues, was formed by a piece of cardboard *C*, of known dimensions, suspended to one arm of the beam of a balance, and placed at the edge of the mantel-piece in the ascending current. The graduated stem of a broken thermometer *t* was suspended to the other end of the beam, and was placed in a glass vessel containing water; weights were placed on the card-board till the zero-point of the graduated stem was level with the surface of the water. The degrees were read with the assistance of a magnifier *G*, and the number of degrees moved indicated the force acting on the card. The value of each degree was found by adding weights to the card. In this way it was ascertained that the force of the upward current at the mantel-piece was considerable, and that it varied in strength. It was strongest in the center, but extended to both sides of the mantel-piece; this upward current had a force of from 15 to 4½ grains to the square foot; the force diminished as the fire got low, but the same action went on even when the fire was extinguished.

Fig. 209.

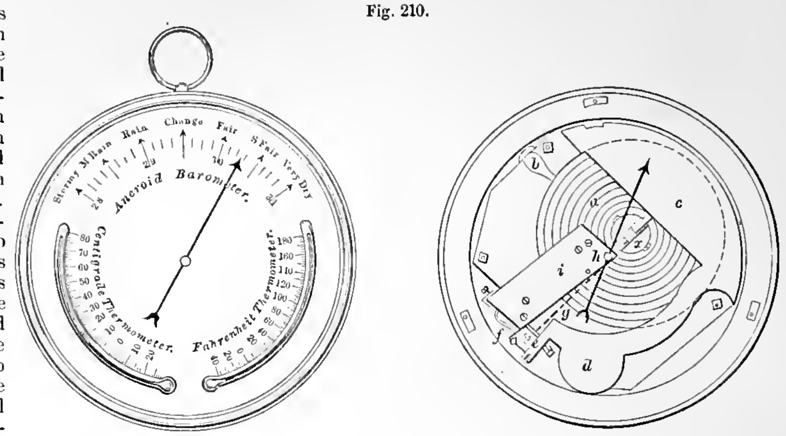


Anemometer.

The greatest pressure of wind ever registered at Glasgow Observatory was 55 lbs. per foot. Professor Airy, however, states that it may reach 80 lbs. per foot in this country, while Mr. Scott Russell asserts that 40 lbs. per foot is about the maximum force which it is necessary to reckon upon in constructing roofs, etc. This is identical with the maximum registered at Menai Bridge.

A-nem'o-scope. An instrument for showing the course or direction of the wind. A weathercock. It is related that Andronicus Cyrrhestes built an octagonal tower at Athens, having at each side a statue of the god to whom the wind blowing from

Fig. 210.



Aneroid.

that quarter was dedicated; and in the middle of the tower was a small spire having a copper Triton, which being put in motion by the wind pointed to the deity from whom it proceeded. The custom of placing vanes on the top of church-steeples is at least as old as the middle of the ninth century; and as these vanes were frequently made to resemble a cock, the emblem of clerical vigilance, they received the name of weathercocks. In the ages of ignorance the clergy frequently styled themselves "the cocks of the Almighty."

Varro is said to have been the first who connected the vane by a rod to a dial in the interior of a building.

This instrument is mentioned by Vitruvius, and was introduced in mansions in the time of William III.

On the Hall of Commerce, London, is an anemoscope connected with an index and dial in a room below, like that of Varro above mentioned.

When thus arranged, the shafts connecting the vane and index should be made of cane, bamboo, or other light material.

The anemoscope may be combined with the anemometer, thus indicating both the direction and the force of the wind. See ANEMOMETER.

An′e-roid Ba-rom′e-ter. An instrument for indicating atmospheric pressure, invented by M. Vidi of France. The action of the aneroid depends on the pressure of the atmosphere on a circular metallic box hermetically sealed and having a slightly elastic top, the vacuum serving the purpose of the column of mercury in the ordinary barometer.

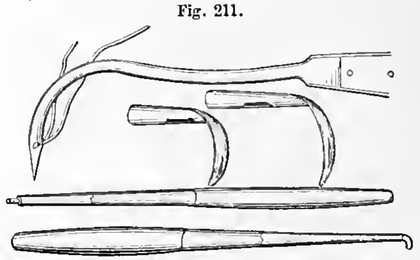
The arrangement is illustrated by the accompanying figures, the first showing the face and the second the interior of the instrument, which is made about $4\frac{3}{4}$ inches in diameter across the face and $1\frac{3}{4}$ inches thick.

The pressure of the atmosphere is shown by the hand pointing to a scale which is graduated with 40 divisions to the inch; one or two thermometers are affixed to the face, but are not essential.

The second figure shows the internal construction, as seen with the face removed, but with the hand still attached. *a* is a flat, circular metallic box, about $2\frac{3}{4}$ inches in diameter and $\frac{1}{4}$ of an inch deep, having its upper and lower surfaces corrugated in concentric circles. This box or chamber, being exhausted of air through the short tube *b*, which is subsequently made air-tight by soldering, constitutes a spring which is affected by every variation of pressure in the external atmosphere, the corrugations increasing its elasticity. At the center of the upper surface of the exhausted chamber is a solid cylindrical projection *x*, about half an inch high, to the top of which the principal lever *c d e* is attached.

This lever rests partly on a spiral spring at *d*; it is also supported by two vertical pins with perfect freedom of motion. The end *e* of the large or principal lever is attached to a second or small lever *f*, from which a chain *g* extends to *h*, where it works on a drum attached to the arbor or axis of the hand, connected with a hair-spring at *h*, changing the motion from vertical to horizontal, and regulating the hand, the attachments of which are made to the metallic plate *i*. The motion originates in the corrugated metallic box *a*, the surface of which is depressed or elevated as the weight of the atmosphere is increased or diminished, and this motion is communicated through the levers to the axis of the hand at *h*. The spiral spring on which the lever rests at *d* is intended to compensate for the effects of alterations of temperature. The actual movement at the center of the exhausted box from whence the indications emanate is very slight, but by the action of the levers this is multiplied 657 times at the point of the hand, so that the movement of $\frac{1}{220}$th part of an inch carries the hand through three inches on the dial. See also BOURDON BAROMETER.

Fig. 211.



Aneurism Needles.

An′eu-rism Nee′dle. A needle for passing a ligature around a dilated artery.

An′eu-rism Tour′ni-quet. An instrument for bringing a pressure upon a sanguineous tumor resulting from the dilation or rupture of the coats of an artery.

The instrument has two legs and a hinge-joint. The pressure being adjusted as required, the hinge is *set* by the key so as to make it rigid.

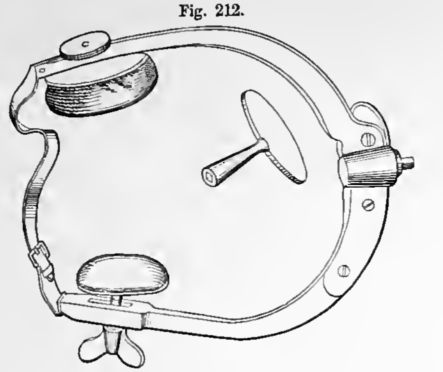
An′gar-i-po′la. (*Fabric.*) A kind of coarse linen made in Spain.

An′ge-lot. A musical instrument of the lute kind.

An′gel-shot. See CHAIN-SHOT.

An′gle. The arris or edge, salient or receding, formed by the junction of two surfaces not in the

Fig. 212.



Aneurism Tourniquet.

same plane. Various are the modes of attaching the two portions; among other devices may be cited: —

Angle-joint.	Feather.	Rebate.
Cramp.	Glue.	Screws.
Dovetail.	Miter.	Tongue and groove.
Dowel.	Nails.	See JOINT.

Pieces at the angles of structures are known as —

Angle-brackets, angle-rafters, angle-ribs, angle-bars, angle-staffs, angle-tie, etc.

An'gle-bar. (*Carpentry.*) The upright bar at the meeting of two faces of a polygonal or bow window.

An'gle-bead. A strip having a rounded edge, and placed at the vertical exterior angle formed by plastered surfaces. A beaded-edge angle-staff.

An'gle-brace. A corner-drill. An angle-tie.

An'gle-brack'et. (*Carpentry.*) One beneath the eave at the corner of a building, and projecting at an angle of 45° with the face of each wall.

An'gle-float. A *float* made to fit any internal angle of the walls of a room.

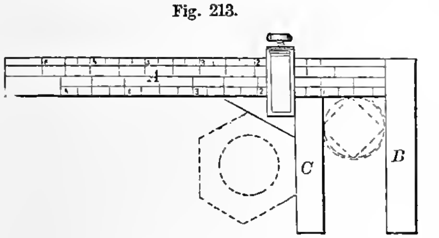
A *float* is a plasterer's trowel.

An'gle-gage. A gage for setting the reflectors on a frame for the exhibition of light under the catoptric system, has two long arms connected by a graduated arc. The arms, having been first placed at the angle which is supplemental to that of the inclination of the axes of the two adjacent mirrors, are made to span the faces of the reflectors, one of which is moved about till its edges are in close contact with the flat surface of one of the arms of the gage.

The instrument has many other applications.

A gage for determining angles of hexagonal nuts. The graduated bar *A* has graduated arms *B* and *C*;

Fig. 213.



Kellogg's Angle-Gage.

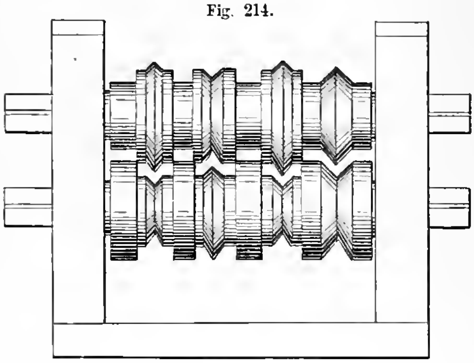
the latter movable, and provided with a block whose edge forms with it an angle of 120° as a gage for hexagonal prisms.

An'gle-i'ron. (*Machinery.*) A bent piece joining the sides of an iron structure. See ANGLE-JOINT.

A description of iron which is used for ship's knees, for uniting the edges of plates which meet at an angle, and for other purposes too numerous to mention. On a larger scale, with more than one bend, it may form a beam, girder, or rail, the difference consisting rather in proportions and purpose than in construction. The fagoting and construction of wrought-iron beams will be considered under BEAM, WROUGHT-IRON. Some devices substantially similar in inventive features will be found under RAILROAD-RAILS, FAGOTING, and ROLLING; the difference between a railroad-rail and a girder is one of shape and proportion of the parts, as will be seen by comparing their cross-sections.

LEWIS, April 26, 1864. The rollers have flat faces, and a central triangular groove, and rib respectively, so that the bar can be introduced between the rollers flat, instead of cornerwise. The effect of this is, that both sides of the angle-iron when finished run parallel to the layers of the original bar, and not crosswise, as is the case with

Fig. 214.



Lewis's Machine for Rolling Angle-Iron.

one side of the angle-iron when rolled in the ordinary manner. The parallelism of the wings with the top of the pile is maintained till the bar is reduced nearly to its proper thickness, when it is finished by passing it through a plain rectangular groove which turns up the wings and finishes them with a grain conformable to that of the original bar.

The ordinary angle-iron is a bar whose section

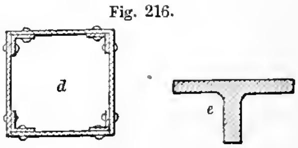
Fig. 215.

Angle-Irons.

forms two sides of a triangle, but the term now includes other shapes, such as the cruciform, etc.

a is an angle-iron forming two sides of a right-angled triangle; *b* is a flatter form with two flanges, and is called "*channel-iron*"; *c* is cruciform in cross-section. It is called "*cross half-lattice iron.*"

Fig. 216.



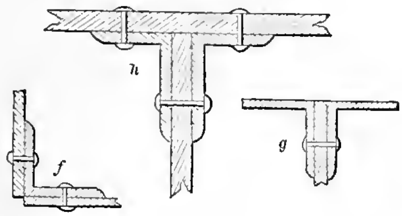
Box-Girder and T-Iron.

d, Fig. 216, shows the application of angle-iron in making a box-girder, or wrought-iron cell; *e* is a form having a *tread* and *web*. It is called T-iron. Other forms are known as Z-iron, I-iron, etc.

Fig. 217 shows the mode of using angle-iron in compound girders, tanks, and other structures.

f shows its application to uniting the angular junction of two plates.

Fig. 217.



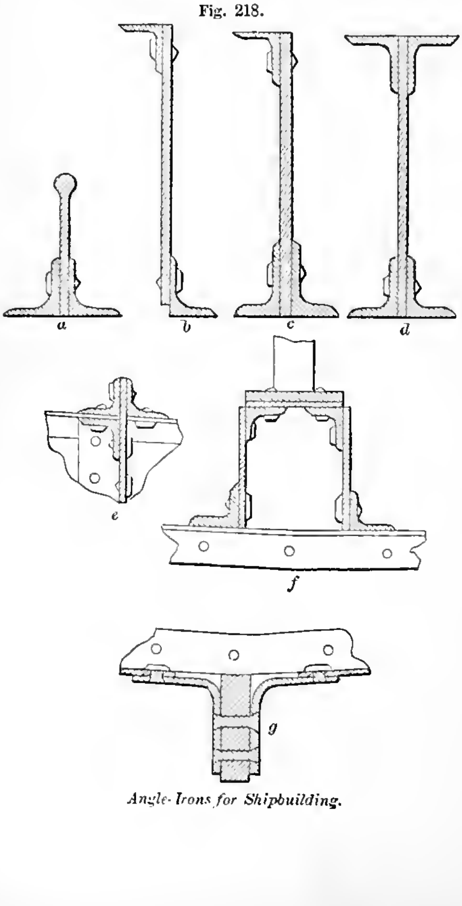
Angle-Irons.

g shows a beam strengthened by angle-plates at each side.

h shows angle-plates uniting a tread-plate and its web.

Angle-bars for shipbuilding are bent and worked into the various forms required in ships, by men called angle-iron smiths; they are then punched with holes, generally about the center of the arm, and by the rivets inserted in these holes the angle-iron is attached to the plates of the ship. The dimensions are usually given in the specification of

Fig. 218.



Angle-Irons for Shipbuilding.

a vessel in this form, namely, 3 in. × 3 in. × ½ in. This means that each arm of the bar is to be three inches from the angle, and the thickness in the center of arm, or at the rivet-hole, half an inch.

As angle-iron is generally applied for the ribs of a ship, the arm which is perpendicular to the surface of the plates is that which is in the position to afford the greatest stiffness to the shell. On this account angle-iron has been rolled with arms of unequal lengths, that the greatest strength may be obtained from a given quantity of iron.

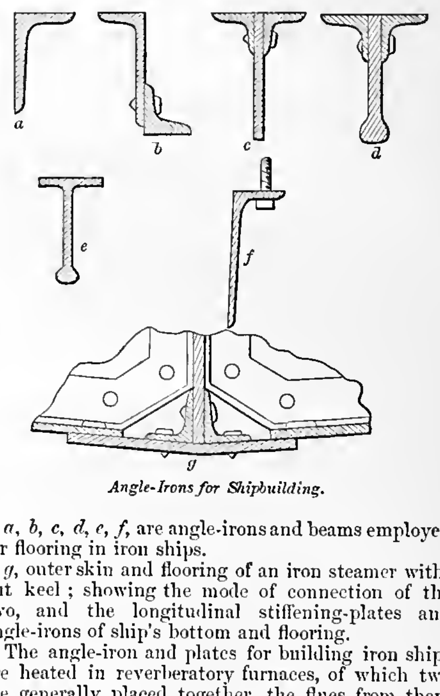
a, *b*, *c*, *d*, are angle-irons and braces for flooring in iron ships.

e shows the connection of outer skin and inner flooring by angle-irons.

f is the arrangement of angle-irons and braces for stiffening ship's bottom longitudinally; answering to the keelson in wooden vessels.

g, keel; showing its connection to the outer skin and beams.

Fig. 219.



Angle-Irons for Shipbuilding.

a, *b*, *c*, *d*, *e*, *f*, are angle-irons and beams employed for flooring in iron ships.

g, outer skin and flooring of an iron steamer without keel; showing the mode of connection of the two, and the longitudinal stiffening-plates and angle-irons of ship's bottom and flooring.

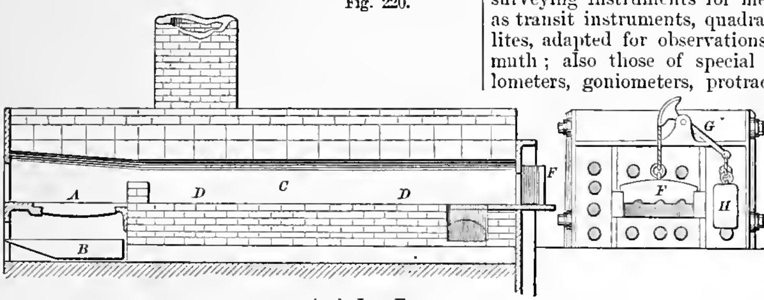
The angle-iron and plates for building iron ships are heated in reverberatory furnaces, of which two are generally placed together, the flues from them leading to one chimney. They are formed of brick and have a brick turned arch, the sides being secured by *binding-plates*, like a *puddling-furnace*.

One furnace is made wide, say 4½ × 10 feet, and is suitable for heating plates; the other long and narrow, say 2 feet wide by 25 feet long, and is used for heating the angle-bars which go to make the frame. An iron sill is placed across the doorway on which the *angle-iron* slides in entering or withdrawing.

The furnace *A* has the usual grate-bars, and a pan *B* beneath, filled with water, cools the ashes as they fall and thus preserves the bars from injury.

This furnace is fed with coals, the flame of which passes along the chamber *C*, and over the brick bed *D*, on which the plates or bars are laid. The roof over the whole is a brick arch, about two feet from the bed, acting by reverberation, to concentrate the heat upon the iron. The flame and hot air then escape down a narrow flue, situated across the mouth of the furnace, and leading by the main flue to the chimney. The end at which the plates or bars are inserted and withdrawn is closed by a door *F*, framed of iron, and enclosing fire-bricks. This, being very heavy, is suspended by a chain, and this chain is attached to a lever *G*, having a balance-weight *H* suspended from it, that the men may have less difficulty in raising and lowering it.

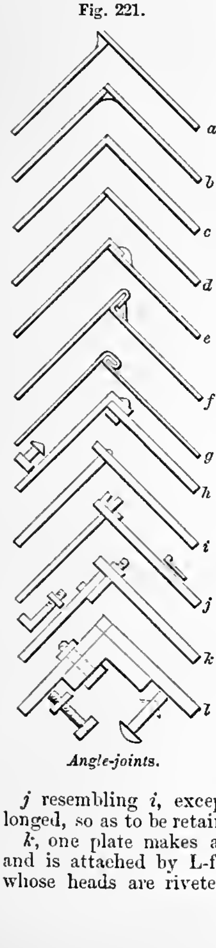
Fig. 220.



Angle-Iron Furnace.

An'gle-joint. Angle-joints differ according to the material, thickness, purpose, and exposure.

Fig. 221.



Angle-joints.

a, *b*, are joints which are entirely dependent upon solder; such are used with tin-ware and sheet-lead.

c is a *miter-joint.* It is used for thicker metals with hard solders.

d is a *butt-joint;* otherwise similar to *c*.

e is a *lap-joint*; the metal is creased over the *hatchet-stake* or by the *spinning-tool.* It requires solder.

f, one plate is bent rectangularly, and the other is doubly bent so as to recurve back on itself, lapping *around* the edge of the other. It needs solder to keep it from slipping apart.

g has a fold to each plate; these *lock* upon each other and require no solder to perfect their hold, although it may be added to make the joint air and water tight where the closure is not absolutely perfect.

h is a riveted joint, one plate being bent to lap upon the other. This *joint* is called the *folded angle*, and is common in all sizes of work, from domestic utensils to steam-boilers.

i, the edge of one plate is formed into tenons which enter mortises in the other, and are there riveted.

j resembling *i*, except that the tenons are prolonged, so as to be retained in the mortises by *cotters.*

k, one plate makes a butt-joint with the other, and is attached by L-formed rivets or screw-bolts, whose heads are riveted to one plate, while their screw-stems pass through the other plate and are fastened by nuts.

l, the two plates are secured by being bolted or riveted to an angle-iron, which is straight or bent into sweeps according to the shape of the object.

An'gle-me'ter. Any instrument for measuring angles. The term seems to have become more particularly applied to an instrument made use of by geologists for ascertaining the dip of inclined strata.

In the broader sense of a measurer of angles it would include a great number of astronomical and surveying instruments for measuring angles, such as transit instruments, quadrants, sextants, theodolites, adapted for observations in altitude and azimuth; also those of special adaptation, as angulometers, goniometers, protractors, etc., which are treated under their respective heads.

An'gle of Re-pose'. (*Civil Engineering.*) 1. The utmost inclination at which a carriage will stand at rest upon a road. At the *angle of repose*, the gravity of the load and the friction of the load are equal. See FRICTION.

2. The natural angle at which the soil of a cutting or embankment will stand without slipping. See SLOPE.

An'gle of Sight. (*Ordnance.*) The natural angle of sight is the angle between a line drawn through the axis of the bore, and a line drawn from the rear of the base-ring to the swell of the muzzle or to the top of the sight.

An'gle-plane. A plane whose bit reaches into a re-entering angle.

An'gle-raft'er. (*Carpentry.*) A rafter at the hip of a roof, receiving the heads of the *jack-rafters* or *cripple-studding.*

An'gle-staff. A strip of wood fixed to the vertical angle of a wall flush with the plastering of the two planes. It is designed as a substitute for plastering in a situation so much exposed.

A round staff is known as an *angle-bead.*

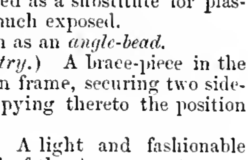
An'gle-tie. (*Carpentry.*) A brace-piece in the interior angle of a wooden frame, securing two side-pieces together and occupying thereto the position of a hypothenuse.

An-go'ra. (*Fabric.*) A light and fashionable cloth made from the wool of the Angora goat.

An'gu-lar File. A locksmith's file for working into the corners of the wards in keys.

An'gu-lar Gear'ing. The wheels are quadrilateral, and the speed of the driven wheel is variable. The driving-wheel, rotating at regular speed, will impart a quicker rate to the other wheel when the angle of the former is in contact with the flat side of the latter, and conversely. Has been used in printing-presses.

Fig. 222.



An'gu-lar In'stru-ments. (*Surveying.*) One in which the horizontal angles are measured by a divided circle and verniers as well as by the needle; as the superior kinds of railroad compasses, the engineer's and surveyor's transits, etc.

An'gu-lar I'ron-band. A ferrule angular in its cross-section. A square, or other sided collar or binding-hoop.

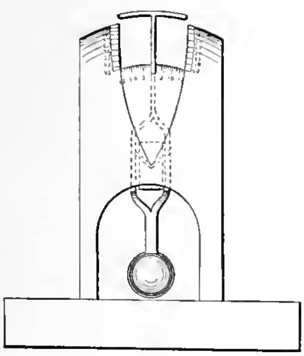
An′gu-lar Thread. A screw-thread whose projection beyond the barrel of the screw is triangular in cross-section. In contradistinction to a *square* thread.

An-gu-lom′e-ter. This instrument is defined by Francis as one for measuring exterior angles. The terms angle-meter and goniometer might be held to mean the same thing judging by their derivation, but the former is applied to instruments used by geologists for measuring the dip of strata, and the latter for measuring the angles of crystals.

A try-square may be termed an angulometer, "a bent measure."

THAYER, August 26, 1862. This invention consists in so constructing and hanging a pendulum, and connecting it with a portion of the surface of a sphere, that it will indicate at once whether any plane to which it is applied is level; and if not so, will show the degrees of the angle, whether of elevation or depression, which such plane makes with the horizon.

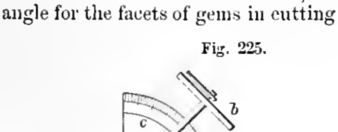
Fig. 223.



Thayer's Plane Angulometer.

The pendulum moves upon three or more bearings in the same plane, and carries upon its top a graduated arc, acting in combination with the spherical surface and the opening therein.

Fig. 224.

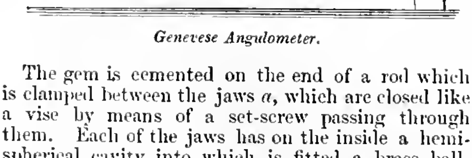


Hall's Angulometer.

HALL's angulometer has two hinged legs, and a graduated arc which indicates the dihedral angle.

An instrument called a *cadrans*, for measuring the angle for the facets of gems in cutting and polishing.

Fig. 225.



Genevese Angulometer.

The gem is cemented on the end of a rod which is clamped between the jaws *a*, which are closed like a vise by means of a set-screw passing through them. Each of the jaws has on the inside a hemispherical cavity into which is fitted a brass ball. A tube passes through the ball, and carries at its upper end a small graduated disk. The cement-stick, carrying the stone to be cut, fits within the tube sufficiently tight to hold it while a facet is being cut, and the upper end of the stick has a pointer by which the divisions on the disk are read off.

Fig 226

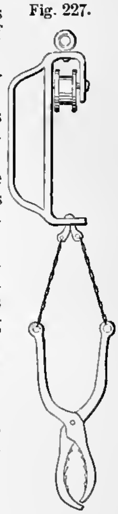
Noose Clutch.

The vertical angle of the tube is determined by the quadrant *c*, fixed on one side of the jaws *a*, and the tube is retained at any angle by closing the jaws upon the ball. The divisions of the quadrant admit of any degree of vertical inclination upon the *skive*, or of vertical position when grinding the *table* or *collet*.

The facets around the stone will be determined by twisting the cement-stick in the tube, until the index marks the required division on the disk *b*.

An′i-mal Black. Carbonaceous matter obtained by the calcination of bones in close vessels. Used in filtering, deodorizing, defecating, discoloring syrups, liquors, solutions.

Fig. 227.



Hog-Hoister.

An′i-mal Char′coal. Calcined bones prepared for sugar-refining. See BONE-BLACK FURNACE.

An′i-mal Clutch. A gripping device for catching animals by the leg. It is especially used for slinging animals during the operations of slaughtering.

In the noose form, Fig. 226, the chain is attached to one end of the plate, and the key on the end of the chain engages in the slot to form a bight for looping around the leg of the animal.

In another form, Fig. 227, the gambrel of the animal is clutched by the gripping-jaws which are attached by chains to the frame, whose roller travels on a way-rod to transport the hog from the "sticker" to the scalding-tub, or from the latter to the "gutter."

An′i-mal′cule Cage. A cell in which living microscopic objects are kept and exposed to view.

An′i-mal-iz′ing Fi′ber. The process of conferring upon vegetable fiber the physical characteristics of animal fiber. Cotton, under the microscope, is a ribbon-shaped tube, and when treated with a cold, strong solution of caustic soda, shrinks and assumes the form of a simple cylinder. It becomes stronger, smaller, and has an increased capacity for receiving coloring matter.

An′i-mal Poke. A yoke placed upon an animal to keep it from pushing down or jumping fences. See POKE.

An′i-mal Pow′er. The expression of the numerical values of the results of the labor of men and animals, particularly horses, is a subject which on account of its eminently practical bearing has attracted considerable attention among scientific as well as practical men.

A work entitled "De Motu Anamalium" was published as far back as 1680 by Borelli, but Coulomb, who devoted a great deal of attention to the matter, has furnished more information of practical value than any other writer.

The unit of value employed by Coulomb was 1 kilogramme (2.2047 pounds) transported a distance of one kilometre (6.214 miles) the total force exerted being estimated by the number of kilogrammes of the burden multiplied by the number of kilometres it is transported during a working day of eight hours; these measures are of course readily reducible to any other denominations, as pounds and miles.

Coulomb ascertained that on an average a man could travel unloaded 31 miles per day; and supposing his weight to be 160 lbs., the expression for the effect exerted by him would in this case be $160 \times 31 = 4,960$ pounds carried one mile per day. He found also, by the average of the work performed by the porters of Paris, that a man could carry a burden equal to 128 lbs. 9.72 miles per day. Assuming the weight of the man to be 160 lbs., the total effect produced would be equivalent to $160 + 128 \times 9.72 = 2,799$; but the transportation of his own weight formed no part of the useful effect, which is consequently expressed by $128 \times 9.72 = 1,244$.

The useful effect is found to be at a maximum when a man is loaded with 121 pounds; under this burden he can walk $10\frac{1}{3}$ miles per day, giving an effect of $121 \times 10\frac{1}{3} = 1,250$.

A porter going short distances with a burden and returning unloaded, as usually occurs, carries 135 lbs. 7 miles per day. A man can wheel 150 lbs. in a wheelbarrow 10 miles in the same time.

The maximum effect of a strong man exerted for $2\frac{1}{2}$ minutes is estimated at 18,000 pounds raised one foot in a minute; and the force of a man of ordinary strength exerted in lifting is equivalent to 30 lbs. raised $2\frac{1}{2}$ feet per second for ten hours, or 4,500 lbs. raised 1 foot per minute; the estimated power of a horse being equivalent to 33,000 pounds raised one foot in the same time, according to Boulton and Watt's experiments.

The following statement by Hachette shows the force exerted by the strength of men applied in various ways, expressed in terms equivalent to the number of pounds carried by a man one mile during a day of eight hours.

Drawing a light four-wheeled wagon over moderately uneven ground . . .	857 lbs.
Pulling horizontally at a rope attached to a weight and passing through a pulley	378 "
Rowing in a boat	374 "
Pushing horizontally, as at a capstan .	368 "
Turning a winch and axle	159 "

The above estimates are based on the average strength of men generally, and in many instances, especially in carrying weights, are largely exceeded; thus it is said that a London porter will carry 200 lbs. on his shoulders at the rate of three miles an hour, but such efforts cannot be sustained for any great length of time. The porters of Constantinople are said, by a judicious distribution of their burdens, to carry much greater weights than this for considerable distances.

The useful effect of a horse walking in a circle, as in turning a mill, is estimated at	800 lbs.
A horse carrying a load of 200 lbs. 25 miles per day	5,000 "
An African dromedary carrying his rider (160 lbs.) can travel for 9 or 10 hours at the rate of between 7 and 8 miles per hour; say $160 \times 9\frac{1}{2} \times 7\frac{1}{2} =$	11,400 "
An Asiatic camel can carry a load of from 500 to 800 lbs. at the rate of $2\frac{1}{2}$ hours; this for a day of 8 hours would give (assuming the load to be 600 lbs.) $600 \times 8 \times 2\frac{1}{2}$ or . . .	12,000 "

A draft-horse can draw 1,600 lbs. 23 miles per day, the weight of the carriage being included.

In hauling for short distances and returning unloaded, a horse will draw on a good road 2,000 lbs. or more, exclusive of the weight of the cart.

In drawing a load the greatest effect is found to be produced when the traces are perpendicular to the collar; as the position of the horse changes in heavy pulling, the traces become more nearly parallel to the road. With very heavy drafts, loading the back of a horse is found rather advantageous than otherwise, by not compelling him to incline forward so much and enabling him to use his muscles in a more advantageous position. The circle in which a horse moves in turning a mill should not be less than 25 or 30 feet; 40 feet is better.

According to Tredgold, a horse can draw, as indicated by the dynamometer, 125 pounds at the rate of $2\frac{1}{2}$ miles per hour, which for one day will give $125 \times 2\frac{1}{2} \times 8 = 2,500$. By the experiments of Boulton and Watt they determined that a good horse can draw 125 pounds at the rate of 3 miles per hour, $125 \times 3 \times 8 = 3,000$ pounds one mile in a day. Multiply this amount by the number of feet in a mile, and divide the product by the number of minutes in 8 hours; the result is 33,000, which stands for the number of pounds raised one foot per minute, and this is now the admitted measure of a horse power.

An'i-mals. In the nomenclature of the mechanic arts, the names of animals have not been entirely overlooked e. g.: —

Ass.	Cricket.	Hound.	Rat.
Bear.	Crow.	Jack.	Seal.
Bee.	Dog.	Jenny.	Serpent.
Beetle.	Dolphin.	Kite.	Skate.
Buck.	Drill.	Leech.	Slug.
Buffalo.	Fish.	Lizard.	Snail.
Bull-dog.	Fly.	Mole.	Sole.
Butterfly.	Fox.	Monkey.	Starling.
Camel.	Frog.	Mouse.	Swift.
Cat.	Goose.	Mule.	Throstle.
Cock.	Hawk.	Pig.	Turtle.
Cow.	Hedgehog.	Pike.	Urchin.
Crab.	Hog.	Ram.	Worm.
Crane.	Horse.		

Each of these useful animals is described in its alphabetical place.

An'i-mal Trap. A device for catching animals. There are numerous varieties; some to set in the path of the animals, others are pulled off by a person on watch; the more common forms are those in which the animal is the cause of his own capture by meddling with the bait, or by crawling into his prison in search of food.

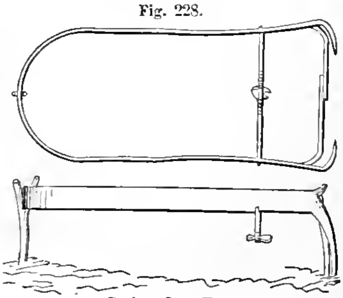
A few instances of different arrangements will be given.

1. The *guillotine-trap* has a descending knife or row of spikes which descends vertically upon the animal which is tampering with the bait.

2. The *rotating-claw* is actuated by a spring on the axis, and is released by nibbling at the bait. It strikes the animal, and throws him to a distance, resetting itself.

3. The *dead-fall* is a weight or spring bar, released by the animal, either by stepping on a platform or touching the bait.

Fig. 228.

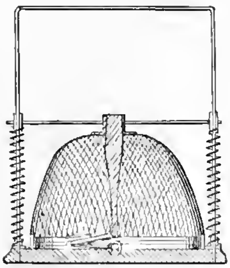


Spring Jaw-Trap.

4. The *gripping-jaw-trap* is shown in the familiar form wherein the jaws are actuated by a spring released by the depression of a small platform between them. Another form of jaw-trap is

seen in Fig. 228, in which the spring and jaws are made of one strip of steel, and the brace, which keeps them apart, has the bait attached; a trigger releases the jaws, which grasp the animal that is pulling upon the bait.

Fig. 229.



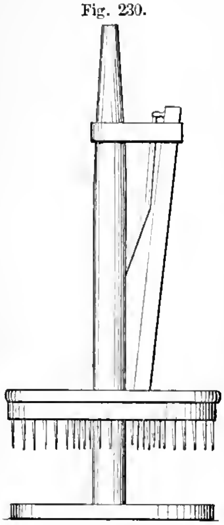
Falling-Cage Trap.

The illustration shows the mode of setting the trap. The forward part stands on two legs, and the bow at the rear is supported on a little crotch.

5. The *falling-cage.* This may be a wire basket, as in Fig. 229. The bell-shaped cage is suspended vertically above the platform; it rests upon a toggle-jointed bar, and is released by the baited trigger, which allows the toggle to double up.

Another form of dropper is shown in Fig. 230. A disk with a circular series of vertical wires.

Fig. 230.



Dropping-Cage Trap.

The arm which rises vertically from the falling disk has at top a staple which rests on the top of a vibratable lever, to which the bait is tied.

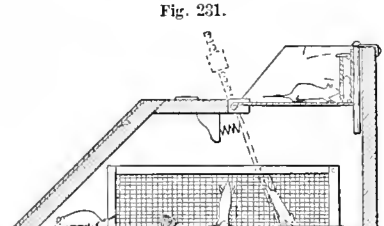
The fall of the disk imprisons or impales the animal.

6. The *gravitating-platform* has many forms. Fig. 231 may be taken as an illustration.

Pressure on the swinging bait-box releases the platform, which swings and precipitates the animal into the cage beneath. The adjustable weight returns the platform to place, when it becomes reset.

The essential features of these traps are a falling platform, a resetting device, and a receiver beneath. The resetting is sometimes done by a spring, sometimes by a weight, in some cases by the animal in passing to an interior chamber.

Fig. 231.

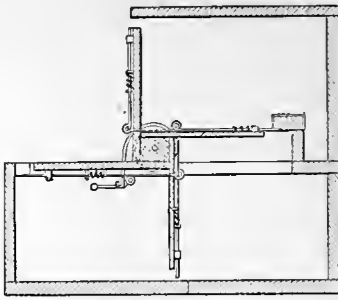


Falling-Platform Trap.

7. The *rotating-platform*, Fig. 232, has a number of platforms brought successively into use.

A series of wings is attached to a rotary-shaft that is actuated by a weighted cord, so that they consecutively assume a horizontal position, forming a platform upon which the rat stands while nibbling at the bait, and from which he is thrown down into the trap.

Fig. 232.

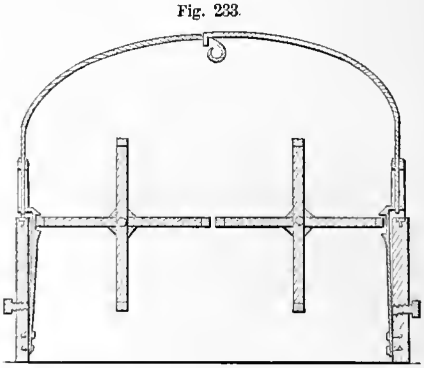


Rotary-Platform Trap.

In another form, the wheel is rotated by a coiled spring, the radial wings being in turn detained by their latches, which catch upon a detent-lug on the case. The motion of the oscillating platform disengages the latch, the wing descends, and the next becomes ready for duty.

Fig. 233 has a duplication of the rotary feature. The invention consists of two radial rotating-platforms, each held in position by separate triggers, but the wires controlling them come together at the bait-hook, which forms one of them.

Fig. 233.

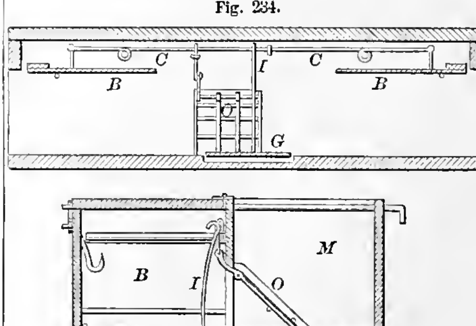


Gatchell's Trap.

Each wire is connected with a rock-shaft, and the triggers or detents are withdrawn by the pulling of the bait by the animal, whose resting-place is at the center, upon two wings. Upon the animal falling into a receptacle below, the trap is reset.

8. The *falling-door.* Several forms of traps which come under this class are familiar to the public, some with one door, and some with two.

Fig. 234.

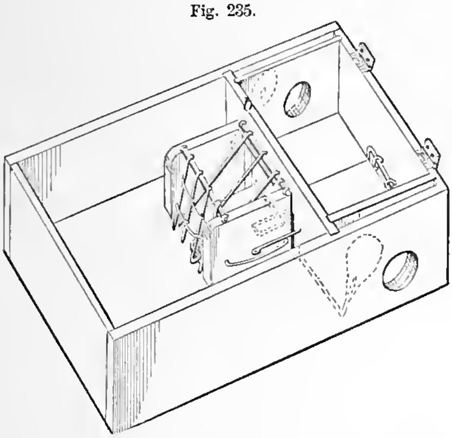


Falling-Door Trap.

Fig. 234 is open at both ends, when set, the doors *B* being supported by triggers. The animal standing on the platform *G*, to reach the bait on the hook, operates the rods *I*, *C*, and releases the doors, which fall simultaneously. This darkens the trap, and the animal lifts the grating *O* in passing to the light chamber *M*. The opening of the grating *O* resets the trap.

9. A *sliding-gate*. Of these there are several varieties. In Fig. 235 the animal passes through one of the holes into the first chamber. His weight

Fig. 235.

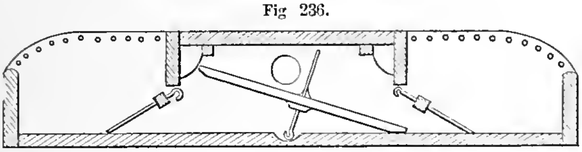


Sliding-Gate Trap

on the platform brings the shutters over the holes and prevents his return. In passing through the grated door into the next chamber he resets the trap.

In Fig. 236 the box is provided at its center with an oscillating platform, to which is rigidly attached an upright leaf or partition of the same width, which has its openings for the entrance

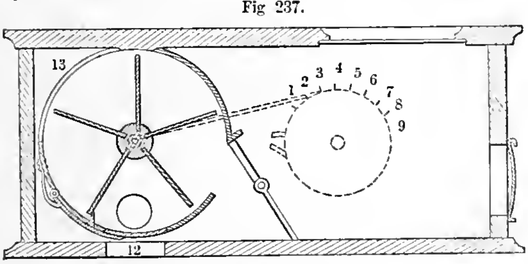
Fig 236.



Baker's Trap.

of the animal so arranged that when it depresses the tilting platform by its weight, the said attached leaf or partition is thereby swung past said opening, leaving the opposite side of the platform in like manner open to admit the next visitor. The entrapped animal escapes on either side into a closed apartment.

Fig 237.



Revolving-Gate Trap.

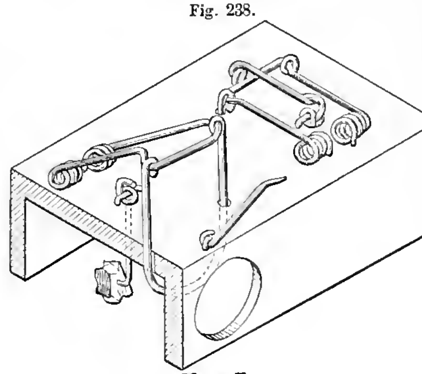
In another form the box forming the trap is provided with two apartments, separated in the usual way by a hinged grating, or self-closing door. In the first apartment is arranged a revolving shaft armed with vanes or paddles, and actuated by a spring. The animal, on entering this first apartment, releases by means of a treadle the detent of the revolving vanes, which press the said animal forward, causing him to enter the inner chamber, the said detent immediately checking the further revolution of the vanes. An index on the outside of the trap indicates, by the number of vanes released, the number of animals caught.

10. The *cage*. This class includes those in which an inverted wire basket is entered between a set of converging wires which oppose a return.

Sometimes this form of trap has a grated inclined door.

11. The *noose*. This is a very old form of snare, consisting of a running noose placed in the path of the animal. Such were the "*springes* to catch woodcocks," of old Polonius. They are used by poachers in England for snaring hares, and by boys for catching the less aristocratic rabbit.

Fig. 238.



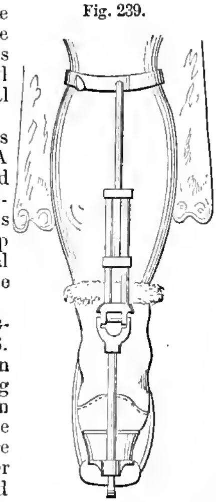
Mouse-Trap.

Among barbarous nations and frontiersmen a snare of this kind is attached to a sapling bent over and held by a trigger. The springing of the trigger releases the sapling, tightens the noose, and swings the animal clear of the ground.

The common mouse-trap is another form of the noose. A bow of spring wire is depressed at an opening, and the tampering with the bait allows the loop to spring up and strangle the animal against the top of the opening. (Fig. 238.)

Anklets. CUNNINGHAM, March 20, 1866. The frame is made in three portions, reaching from a garter-band on the leg to the skate. The upper two portions are extensible on each other as the limb is flexed and extended, and the middle piece hinged to the lower

Fig. 239.



Cunningham's Ankle-Supporter.

one to permit the said motion. It is intended to stiffen the ankle-joint and prevent the ankle turning sideways in skating.

The term is also applied to an article of dress which forms an extension above the top of the bootee or the shoe, and forms in some cases a protection for a weak ankle, in others is merely an ornamental extension.

Stockings, stiffened with steel springs or whalebones, worn as a protection to weak ankles, may also be termed anklets.

See GAITERS.

Annealing. Annealing is a process used in the manufacture of glass and iron for the purpose of rendering them less brittle. It is performed by allowing them to cool very gradually from a high heat, a sudden reduction of temperature rendering them hard and brittle. The singular properties of enameled glass are strikingly shown in Prince Rupert's drops and the Bologna vial. The former are prepared by allowing melted glass to drop into water, where the drops which are not broken by contact with the water form irregularly elongated globular bodies tapering to a tail at one extremity. These will bear a considerable blow on the thick end without breaking, but if a small piece be snapped off the tail the whole immediately falls into powder, emitting a cracking sound.

The Bologna vial is a rude flask of some three or four inches in length by about one in diameter, and from $\frac{1}{10}$ to $\frac{1}{8}$ of an inch in thickness.

If a leaden bullet be dropped into it from a height of three or four feet, or it be struck a smart blow on the outside with a stick, it will not break, but the dropping of a grain of sand or a small sharp fragment of flint into it will cause it to crack and fall to pieces.

Upon the proper annealing of glass much of its utility for many purposes entirely depends, and for vessels which are to be subjected to great extremes of heat and cold, careful annealing is absolutely indispensable. Its neglect is one of the principal causes of the breakage of so many lamp-chimneys, tumblers, etc., whose cost often forms such a considerable item in domestic expenditure. See GLASS.

Annealing is also a necessary process in the manufacture, by drawing, of wire and small tubing, as well as in making brass, copper, or sheet-iron vessels by hammering and rolling; the metal, by compression, becoming too hard and brittle for further reduction until annealed, after which it recovers its former softness and pliability.

When molten glass is allowed to cool slowly, its particles assume a fibrous arrangement, which imparts a certain elasticity to the whole mass, so that it can transmit vibrations from one extremity to the other. When suddenly cooled, the interior particles are enclosed by the solidification of the exterior before they have assumed the fibrous condition which insures the elastic structure or condition.

Glass may be annealed by placing it in tepid water, boiling it for a considerable length of time, and then allowing it to cool gradually.

Glass-ware is annealed by placing it, while yet hot, in an oven, technically called a *leer*, in which the glass is allowed to cool very gradually. A common form of the *leer* is a long oven, with sliding or travelling pans to hold the glass-ware, which enters at one end, as hot as it comes from the hands of the glass blower or presser, and by the gradual accession of pans of ware is pushed to the other end, whence it issues at a temperature which permits it to be handled. The particles of glass are supposed to assume a different structural relation, when thus slowly cooled, which favors their cohesion, and permits a certain degree of resiliency or elasticity. When cooled suddenly, there seems to be an inherent strain, a compulsory union, but faulty and fragile static condition, whose equilibrium is disturbed by an excitant in the form of a blow, which generates a tremulous motion among the particles, and permits them to yield to the disruptive force. This disruptive tendency may arise from want of homogeneity, unequal contraction, or something else.

In the annealing of metals, cast-iron for instance, the metal is brought to a red heat, and then allowed to cool slowly. The rationale of this process has been variously explained, and the most reasonable seems to be that the particles of metal take a different arrangement under these circumstances from that assumed by them when allowed to cool rapidly. In the latter case the exterior portion of the metal contracts first, and presses upon the interior portion, and the particles of the latter may thereby be compelled to take an arrangement which they would not were the cooling to take place at an equal rate in every part, and the process of cooling be long protracted. It does not seem to be determined whether the protraction of the process is merely necessary to insure an equal rate of cooling in every part, but it is not a violent conjecture that the said slowness may favor a particular aggregation of the particles, which gives them the greatest possible cohesion attainable with the structural nature of cast-iron. In making cast-iron malleable, as it is termed, a process much used in making builders' hardware, the metal is kept for several hours at a temperature a little below the fusing-point, and then allowed to cool slowly. From the prolongation of both stages of the process in this case, it is evident that the perfect result is best attained by giving the particles time, and not violently changing their structural relation; unless it be held that chemical changes in the furnace (such as parting with a portion of the carbon) have to be taken into consideration, and that the change is not all in the mechanical disposition of the particles. Tempering and annealing are nearly allied, but the processes are not confounded in the arts, owing to their different technical applications. The word "annealing" is derived from the Anglo-Saxon signifying to "kindle," and the heating is a necessary preliminary whether to withdraw the hardness incident to hammering and rolling of malleable metals, or the hardness incident to the rapid cooling of a casting in its mold. The protraction of the process of cooling the casting has a favorable effect upon its toughness and comparative softness. This is plainly seen by comparing them with chill-hardened articles, which are rendered hard and brittle by the sudden cooling.

Exposure of the hot steel to a cold surface renders it hard. This is usually done by dipping the red-hot metal in water, but other cold surfaces which are rapid conductors will answer the same purpose.

A thin, heated blade placed between the cold hammer and anvil is hardened by rapid cooling.

Thicker pieces, under the same circumstances, are somewhat hardened, but may be filed.

Placed on cold cinders, or other bad conductor, the steel cools more slowly and becomes softer.

Placed in hot cinders, and allowed to cool by their gradual extinction, it becomes still softer.

Encased in a close box with charcoal-powder, raised to a red heat, and allowed to cool very slowly, it reaches its softest state, except by a partial decomposition, as in the following process.

The steel is placed in a close box with iron turnings, filings, or scales, lime, or other matters, which will eliminate the carbon from the steel, and reduce it to the condition of pure, soft iron. This is the process used in softening plates and dies under the modern system of bank-note engraving invented by Jacob Perkins (cited below).

Analogous processes are had in the case of cast-iron, producing the various grades of hardness, from the chilled cast-iron to the soft malleable iron-castings.

The annealing of steel, to soften it for the uses of the die-sinker and engraver, is effected by heating it to a bright cherry red, and suffering it to cool gradually in a bed of charcoal. Another process, adopted by the writer, has been to imbed the steel blanks or forgings in lime within a cast-iron box. This is heated to redness in the fire, remaining a sufficient time to insure an equal heat of the articles inside; the box is then removed and buried in hot ashes, which protract the process of cooling for several days. See TEMPERING.

Perkins's process of transfer-engraving is as follows: —

A soft steel plate is first engraved in finished style, either by hand or mechanically, or the two combined, and the plate is then hardened. A decarbonized steel cylinder is next rolled over the hardened steel plate by powerful machinery until the engraved impression of the plate appears in relief upon the roller, the hollow lines of the plate being salient ridges on the cylinder. The roller is then reconverted to the condition of ordinary steel, and hardened, after which it serves for giving the intaglio impressions to any number of decarbonized plates, every one of which is an absolute counterpart of the original. Each plate when hardened will afford 150,000 impressions, and in the event of accident to the transfer-roller, any number of new rollers with the design in cameo may be obtained from the original plate.

The metallurgic process was explained by the inventor in the thirty-eighth volume of the Transactions of the Society of Arts. He there states that to decarbonize the plates they are placed in a vertical position in cast-iron boxes not less than three fourths of an inch thick, and surrounded on all sides by iron filings not less than one half an inch thick. The boxes are then placed in a furnace, and, after being heated, are allowed to cool in the most gradual manner by stopping off all the air-passages, and covering the boxes with a layer of cinders six or seven inches deep.

The plate or roller, as the case may be, having, in the softened state, received its impression, is reconverted in a similar box, wherein it is packed with sifted charcoal, made from leather scraps. After being heated in this cementing box and furnace from three to five hours, the plates or rollers are hardened by plunging vertically into cold water.

The use of steel plates for engraving has but comparatively lately superseded that of copper, and its peculiar value arises from the fact that by the processes of hardening and annealing it is made to assume the opposite conditions of extreme hardness and sufficient softness, so as in the former state to endure wear in printing, and also preserve the sharpness of its lines when enduring immense pressure against a soft steel roller or plate; and in the latter case to be readily cut by the graver or dry point, and have sufficient plasticity to yield to pressure, and insinuate itself into the finest lines of the hardened steel against which it is pressed.

The use of steel in preference to copper may be credited to Mr. Perkins and the engraver Warren. Warren annealed his plates at a high temperature in earthen boxes packed with pounded oyster-shells.

The practice in the Bank of England, as modified by Oldham, is to anneal at one time four cast-iron boxes, each containing from three to six steel plates, surrounded on all sides with fine charcoal, mixed with an equal quantity of chalk, and driven in hard.

The reverberatory furnace employed has a circular cast-iron plate or bed upon which the four boxes are fastened by wedges, and as the plate is slowly and continually revolved by power from the steam-engine which drives the printing-presses and other machinery of the building, the plates are exposed to an equal heat. When the required temperature is attained, all the apertures are carefully closed and luted to exclude the air and extend the cooling over at least forty-eight hours.

The surfaces of the cylinders and plates are thus rendered exceedingly soft to the depth of about $\frac{1}{32}$ of an inch, so as to be almost as impressible as lead and readily yield to the pressure of the transfer-press, where they are brought in contact with the counterpart portion, the softened cylinder with the hardened, originally engraved plate, or the softened plate with the hardened roller, whose design was received during the soft stage from the hardened plate, which had been engraved during *its* soft condition.

In some cases the extremely soft surface of the plates is planed off. In the Bank of England the plates are used for printing without previous hardening, as they can then be repaired, the parts brought up sharply by re-rolling under the transfer-roller. Danger of warping is also avoided.

Though belonging to the *hardening*, and not to the *annealing* process, it may here be mentioned, to complete the subject, that Oldham, Jr., has introduced a plan for precipitating the plates instantly into water, so as to prevent even an instantaneous exposure to the air; thus avoiding scale, or even a rough discoloration. See TEMPERING.

Many recipes are extant in the trade for annealing and hardening compounds; such are frequently heirlooms and preserved with jealous care. Lime and ox-gall are recommended by the operators in the English mint as an annealing composition.

For annealing of cast-iron, see MALLEABLE CAST-IRON.

Ede gives the following directions: —

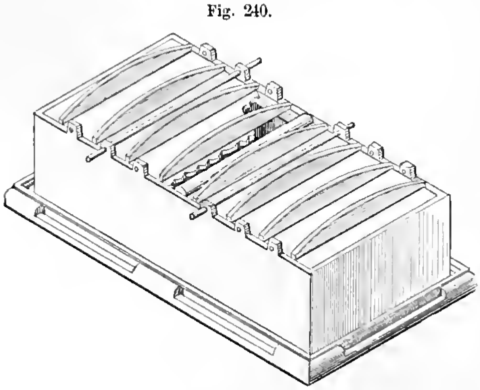
"In the annealing of steel, the same care is required in the heating of it as there is in heating it for hardening, for overheating the steel is as injurious in one case as in the other. In the process of annealing, artists differ very much, some approving of heating the steel and burying it in lime, some of heating it and burying it in cast-iron borings, while others approve of heating it and burying it in sawdust. A far better plan is to put the steel into a box made for the purpose, and fill it with charcoal-dust, and plug the ends up so that the air is kept from the steel, then to put the box and its contents into the fire till it is heated thoroughly through, and the steel is at a low red heat: it must then be taken from the fire, and allowed to remain in the box, without opening the box till the steel is cold. Then when taken out the steel will be nice and clean and very soft, and without those bright spots which some mechanics call pins, and which are no small impediments to the filing and working of steel, and, in fact, the steel is believed to be improved by the process. A piece of stout gas-pipe, with a bottom welded in, and a plug made for the other end, makes a very good box for a small quantity of steel; but, for a large quantity, the box must be large in proportion. If the steel is very large, it is as well to make a charcoal fire to heat it in, and then let the steel and the fire get cold together before it is taken out, and it will be equally soft. But it sometimes happens that a piece of steel is wanted in a hurry, and the steel, perhaps, is too hard to work on, and cannot wait for its being softened in a box; in such cases it may be heated in an open fire, and buried in charcoal-dust till it is cold, or if it be heated to a red heat sufficient to be seen in a dark place, and then plunged into cold water, it will work more pleasantly, but not so soft as if it were heated in a box with charcoal. There are many that do not know the value of a good tool, because the steel they work on has never been properly annealed, and before the tool has half done its duty it is worn out, or wants repairing; whereas, if the steel had been properly annealed, the same tool might have lasted ten times as long without repairing."

The process of annealing gongs, cymbals, bells, and mortars of bronze, is a complete inversion of the process cited above. The gong, for instance, which derives its name from the Chinese *tshoung*, a bell, is a compound of copper, 78; tin, 22. When cast, it is very brittle, from the quantity of tin, which is double the percentage of gun-metal (copper, 90; tin, 10), and between that and the proportions of speculum metal (copper, 43; tin, 20). The speculum metal is called by Ure the whitest, most brilliant, hardest, and most brittle of alloys. (Iridosmine is harder.) The gong when cast is as brittle as glass, but by being plunged at a cherry-red heat into cold water, and being confined between two disks of iron to keep it in shape, it becomes tough and malleable. Other bronze articles may be similarly tempered or annealed, as it has been variously termed.

There are several ways of hardening copper, — by the fumes of phosphorus, by an alloy of the latter, or some other metals, — but these render it brittle and destroy its usefulness for most purposes. In common with many others, Prescott regrets the loss, or rather our non-discovery, of the lost art of tempering bronze. After a careful examination of what has been written on the subject, the writer is inclined to the opinion that the hardness was imparted by judicious alloying with tin and iron, by the hammer, and by a careful use of the annealing process to confer toughness upon the back while the edge was allowed to maintain the hardness necessary for maintaining a sharp edge. See BRONZE; ALLOYS.

LEWIS'S ANNEALING BOX. The top, bottom, and sides consist of three separable pieces, to prevent warping by the heat of the annealing oven. The bottom forms a tray to receive the rectangular frame forming the sides; the top is strengthened by ribs, rests on rabbets in the sides, and is fastened by transverse rods.

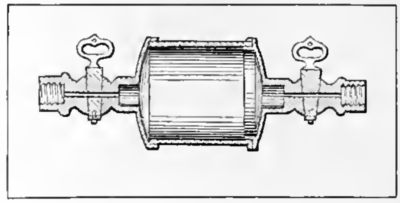
Fig. 240.



Lewis's Annealing Box.

WASHBURN'S WIRE-ANNEALER. The wire is placed in a box, which is then charged with a gas which will not oxydize the wire when the latter is heated. This is for the purpose of preventing the formation of scale, and obviating the subsequent use of an acid bath to cleanse the wire. The vessel is provided with stopcocks by which the air in the interior is displaced and an artificial atmosphere or gas substituted. This is applicable to other articles besides wire.

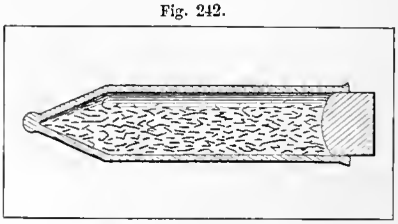
Fig. 241.



Washburn's Annealing Box.

McCARTY, June 11, 1861. The device is intended for annealing cut-nails. The process consists in confining them in a suitable vessel, subjecting both vessel and contents to a red heat, and allowing the whole to cool from six to twelve hours, according to the size of the nails and tube, and maintaining the vessel air-tight during the heating and cooling process.

Fig. 242.



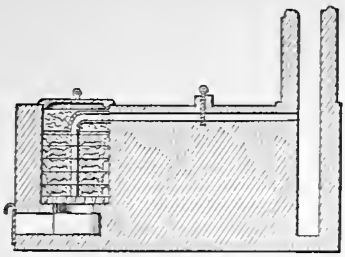
McCarty's Annealing Box.

Much attention has been directed to the annealing of cast-iron car-wheels. The object is to make the web soft and tough, so as to withstand the jar and strain incident to use, and at the same time have a hardened rim which will bear the wear.

WHITNEY, April 25, 1848, placed the wheels in a pile in a cylindrical pit or case in which they were closely covered and left to cool gradually. A non-conducting jacket protracted the period of cooling, and contributed to the effectiveness of the operation.

GEISSE, April 19, 1859. The wheels, while hot, are removed from the molds and piled in a cylindrical oven, where they are allowed to cool gradually. A blast of air is carried through the centers of the hubs, which, as the wheels are symmetrically piled, form a continuous air-duct, at the top of which is a conductor leading to the chimney. Dampers at the ash-pit and also in the chimney afford means for regulating the passage of air and thereby modifying the rate of cooling. By the means described, the wheels are induced to commence cooling at the centers, the cooling gradually extending outward. The heat at no time is sufficient to draw the chill which has been conferred upon them in the mold. The object is to prevent the hubs shrinking away from

Fig. 243.

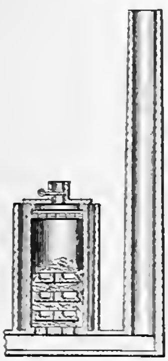


Geisse's Annealing Oven.

the rims after the latter have cooled, as is apt to be the case when the cooling is initiated in the reverse order.

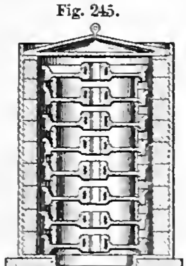
MOWRY, May 7, 1861. The car-wheels, alternating with layers of charcoal, are built up into a pile in a pit, which is so arranged that the quantity of air may be graduated to regulate the combustion, which is designed

Fig. 244.



Mowry's Car-Wheel Annealing.

Fig. 245.

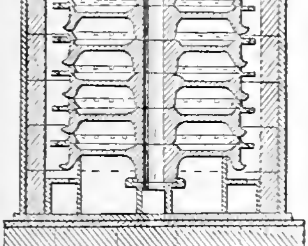


Moore's Car-Wheel Annealing

to be protracted. The double walls of the pit or annealing case form a non-conductor to retain the heat, and allow but a very gradual cooling to the mass.

MOORE, December 5, 1865. The wheels are removed from the molds while hot, are piled one above another in a vertical pit, with intervening rings so placed as to separate the chilled tire from the web which is to be annealed. The interior space around the hubs is filled with charcoal, and the outside space around the tires is filled with sand. The charcoal, being ignited by the heat of the wheels, burns slowly, and anneals the web of the wheel, while the sand protects the tread from the same action, retaining the chilled surface which it has acquired in casting.

Fig. 246.



Moore's Car-Wheel Annealing.

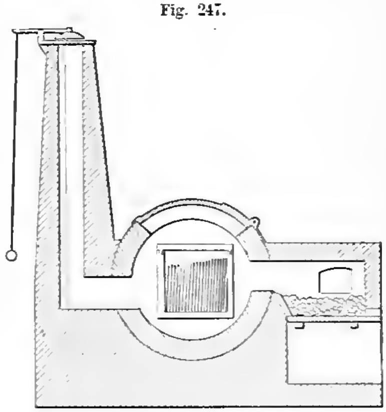
MOORE, October 9, 1866. This varies from the preceding in the mode of introducing the air-draft, and in the mode of isolating the tires.

The car-wheels are piled upon supporting rings at the bottom of the case, so that a passage is formed by the holes through the hubs for cold air, and another passage around the tread of the wheels for the draft for burning the charcoal, which is distributed upon the perforated flanges of the ring interposed between each wheel.

The openings in the base of the annealing case are the means of admission of atmospheric air to aid in the combustion, and this supply is graduated to suit the requirements of the case. Another opening admits air to pass upward through the hubs to cool them.

ELLS's furnace for annealing and polishing sheet-iron. The sheets of metal to be operated on are placed in an iron box or muffle, with layers of oxide of iron, lime, and animal charcoal between them, heating the whole to about eight hundred degrees in a suitable furnace, meanwhile subjecting the box to a rocking and rotating motion.

Fig. 247.

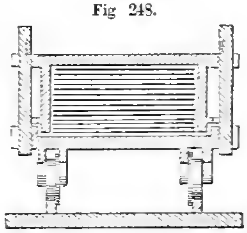


Ells's Annealing Furnace.

The attrition of the particles during the operations of heating and cooling is to give the peculiar mottled and polished appearance of Russia sheet-iron.

In WOOD'S annealing furnace, 1867, the box has track wheels. Its lower plate has an upwardly projecting rim to hold the sand used as luting. The top is a rectangular box, which is inverted over the pack of sheets, and is clamped at the bottom portion.

Fig 248.

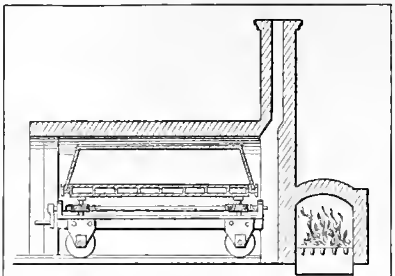


Wood's Annealing Furnace.

The plates are held in rigid compression between the wagon bottom and the inverted box: the object being to prevent discoloration. The truck has wheels by which it traverses on the railway, and is thus run in and out of the oven.

WORCESTER, September 25, 1860. This arrangement is intended to give a solid support to the bed-plate of the box which contains the pack of sheet-iron or the other iron articles which are to be annealed. When the carriage is run into the oven with its load, consisting of some tons of iron, if the bed-plate be supported in but a few places it is apt to warp, which is destructive of the apparatus and injurious to the load then under treatment. In this

Fig 249.



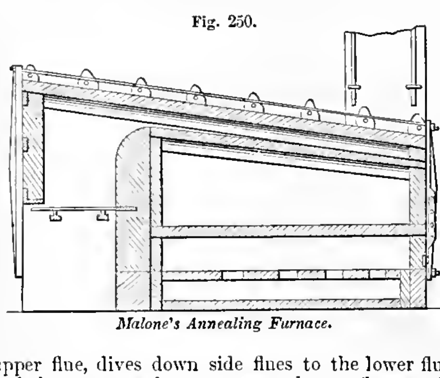
Worcester's Annealing Oven.

oven are dwarf-walls on the sides of the oven, below the level of the bed-plate of the box as it is run into the oven. After the box has reached its position longitudinally, the winch at the end of the carriage is turned and the bed lowered till it rests on the walls. A further turn or two of the winch lowers the supporting posts, so that they run clear of the bed-plate when the carriage is withdrawn. The withdrawal of the charge is the converse of the former action; the carriage being run beneath the bed-piece of the box, the winch is turned so that the posts elevate the bed-plate from the walls, and the carriage is then withdrawn with its load.

In WOOD'S patent, July 9, 1867, the sheets are compressed between the top and bottom of the box, which are temporarily clamped together. The object is to prevent warping and discoloration.

MALONE, May 22, 1866. The furnace is at one end of the annealing chamber; the caloric passes along the

Fig. 250.



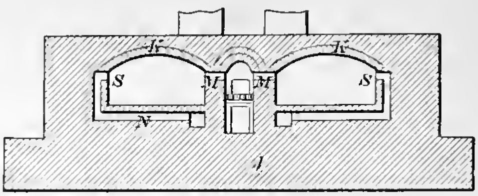
Malone's Annealing Furnace.

upper flue, dives down side flues to the lower flue, and thence passes by apertures and cross flues to the chimney. The object is an even heat at all parts.

REYNOLDS, February 13, 1866. This is an oven for decarbonizing and annealing iron. The caloric current from the furnace passes by the flues *M M*, beneath the arches *K K*, in the chambers, and thence by the diving-flues *S S*, and the lower flues *N*, to the chimney.

Annealing and tempering devices, especially intended for wire, and which act continually upon the wire as it passes through, will be considered under WIRE TEMPERING AND ANNEALING. As before remarked, annealing and tempering are nearly allied; the strictly tempering devices, however, are more conveniently considered under TEMPERING (which see), as they generally consist in means for giving peculiar grades of temper to axes, cutlery, scythes,

Fig. 251.



Reynolds's Annealing Furnace.

springs, etc., and in devices for securing the integrity of the articles under the great strain and change incident to the process.

An-neal'ing Arch. The oven in which glass-ware is allowed to cool gradually in order to anneal it. It is called a *leer* in some departments of glass-making.

The annealing arch of the plate-glass manufacture is called a *carquaise;* the front door, the *throat;* the back door, the *gueulette* (little throat); it is heated by a furnace along the side, called a *tisar*. The nomenclature is French, and indicates the source whence the manufacture was derived.

An-neal'ing Col'or. The color which steel takes in tempering or exposure to progressive heat.

An-neal'ing Fur'nace. A furnace in which metals are heated nearly to fluidity, and then allowed to cool slowly, so as to render them less brittle or to make them malleable.

Or, — as with glass, — a furnace in which the heat is retained for a considerable period in order that the process of cooling may be protracted. A glass-annealing furnace is called a *leer*.

Gold, silver, and zinc are occasionally annealed in the process of working, to render them more tractable. The process is of more especial and frequent application, however, to steel. See ANNEALING.

The annealing furnace for gold or silver in *fillets* or *planchets* has an iron table in front on which a cast-iron carriage is loaded with the metal in jointed and luted tubes; the car and its load are then run on to the floor of the furnace, and the door is lowered.

An-neal'ing Lamp. A dentist's appliance for heating foil used in filling excavations in carious teeth. It is a small alcohol lamp on a stand, and has a tray of mica or german-silver in which the foil is placed. The foil is more adhesive when warm.

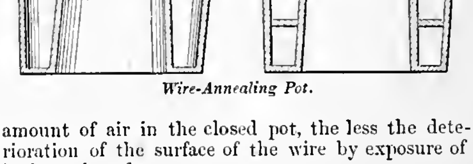
An-neal'ing Ov'en. A chamber in which articles are placed to allow them to cool gradually so as to make them tough. See ANNEALING.

The annealing arch for glass is called a *leer*.

An-neal'ing Pot. A closed pot set in a furnace, and used for exposing an object to heat without forming a scale of oxide.

Pots for annealing wire are made annular, so as to receive with as little vacant space as possible the wire which is coiled therein. The smaller the

Fig. 252.



Wire-Annealing Pot.

amount of air in the closed pot, the less the deterioration of the surface of the wire by exposure of its heated surface.

An-ni'hi-la-tor, Fire. An apparatus for extinguishing fire by the rapid production of carbonic-acid gas, which excludes the vital air from the combustible material. See FIRE ANNIHILATOR.

An'nu-lar Bit. A boring bit which cuts a circular channel, but does not *rout* the central portion.

Wads, buttons, and some other things, are made by a tool of this kind.

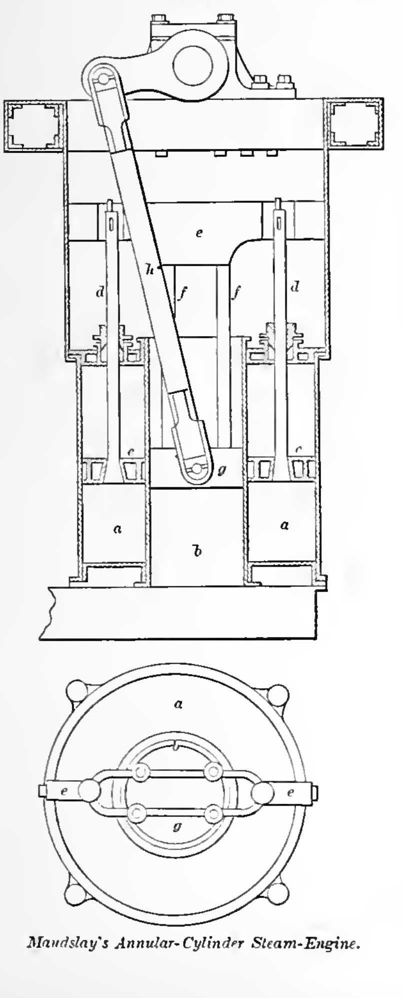
One form of the diamond drill makes an annular groove, leaving a central cylindrical plug of stone. See DIAMOND DRILL.

Several annular boring tools are described and illustrated under AUGER, which see.

An'nu-lar Bor'er. A description of rock-boring tool, in which a circular groove is made in the stone, leaving an axial stem of unbored matter. The tool descends until the stem is nearly as long as the wings of the tool; then, the latter being withdrawn, a grapnel is introduced into the hole, the stem broken off and raised. The borer is then relowered and the work proceeds. This mode of boring is convenient for affording a perfect section of the strata, giving, if care be taken, the dip as well as the quality. See ROCK-BORING TOOLS; GRAPNEL.

An'nu-lar-Cyl'in-der Steam'-en-gine. A form of *direct-acting steam-engine* invented by Maudslay, England, and patented by him in 1841. It consists of fixed inner and outer cylinders, between which is an annular steam space *a*, occupied by a piston *c*. This piston has two rods, *d d*, which pass through stuffing-boxes in the cylinder-head, and are keyed to the cross-head *e*. The latter connects by rods *f f* with the guide-block *g*, which reciprocates in the open-ended cylinder *b*. To a pin on the block *g* is attached the connecting-rod *h*, which passes to the crank on the paddle-shaft.

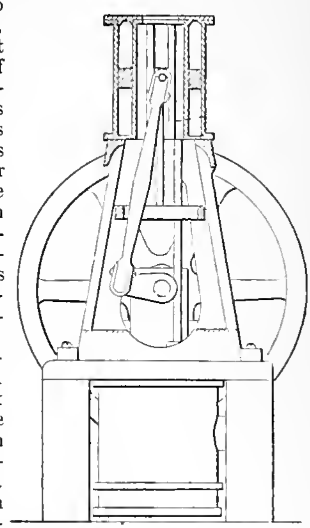
Fig. 253.



Maudslay's Annular-Cylinder Steam-Engine.

In another form of this engine the cylinder is annular and has two piston-rods which connect to a cross-head plate, slotted to permit the movement of the connecting-rod which passes through it. Rods pass up from this plate to an upper cross-head whose slides are within the annular cylinder. The connecting-rod passes from this cross-head to the wrist-pin of the crank.

Fig. 254.



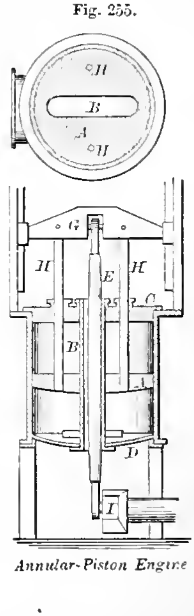
Annular-Cylinder Table Steam-Engine.

It may be necessary to remark that the Trunk Engine and the Annular-Piston Engine are distinct devices. There is a certain similarity of appearance, the inner and concentric cylinder, the most salient feature of novelty in appearance, being present in each engine.

In the *Annular-Cylinder Engine* both cylinders are fixed and the piston reciprocates in the annular intervening space.

In the *Trunk Engine* the annular piston is attached to the inner cylinder (the *trunk*) and reciprocates therewith; the latter slides in stuffing-boxes at the ends of the fixed outer cylinder. See TRUNK ENGINE.

Fig. 255.



Annular-Piston Engine

In another form of this description of engine the parts are somewhat modified. The two cylinder-heads are connected by a trunk which is of flattened form *B*, as shown in the plan. The piston *A* is of corresponding shape, and not strictly annular. It is connected by the rods *H H*, with the cross-head *G*, from which proceeds the connecting-rod *E* leading to the crank *I*. The rods *H H* pass through stuffing-boxes in the upper head *C*, and the trunk *B* connects the heads *C D*.

Perhaps the most gigantic steam-engines in the world are the three engines, the Leeghwater, the Cruquius, and the Lynden, erected 1840–50, for the purpose of draining the Haarlem Lake. This had an area of 45,230 acres, and a maximum depth of seventeen feet below the level of the boezem, or catch-water basin, of the district. The boezem carries the collected waters to the sea, into which it discharges by sluices at Katwyk on the North Sea, and at Sparndam and Halfweg on the Y, or the Southern end of the Zuyder Zee. See *Koninklijk Institut van Ingenieurs*, 1857–9, *plaat* 3, 4.

Each of the three engines mentioned has two steam-cylinders placed concentrically, the one within the other, the outer of twelve feet diameter, and the inner one of seven feet diameter; both are secured to one bottom and covered by one cover, but the inner cylinder does not touch the cover within 1½ inches. There are two pistons, twenty-six inches deep, the compartments of which are fitted with cast-iron plates; the outer piston is annular, and has a packing on both sides; beneath this annular piston a constant vacuum is maintained when working. The two pistons are connected by five piston-rods to a great cross-head weighing about 190,000 pounds. Eight connecting-rods from the cross-head pass to the inner ends of eight working-beams, to whose outer ends the piston-rods of eight pumps are suspended. These pumps are situated in a circular series around the steam-engine, the working-beams radiating from an axis coinciding with a vertical prolongation of the cylinder piston-rod. (See DRAINING, for an illustration of the engine.)

The working of the engine is as follows: —

Steam is admitted below the central piston, and lifts it, the annular piston, the cross-head, and the inner ends of the pump-beams; causing the pump-piston to descend. A hydraulic apparatus is brought into action to maintain the parts in this position until the pump-valves have had time to change. The equilibrium-valve is then opened, the steam passes above both pistons and drives them down, the pressure being nearly equalized on the upper and lower sides of the small piston, while nearly two thirds of it acts on the upper side of the annular piston, which has a partial vacuum beneath it, to aid in the work. The effective stroke is also aided by the dead weight of the cross-head, which weighs over ninety tons, and by the weight of the pistons and rods of the engine.

Each engine has two air-pumps of forty inches diameter, and five feet stroke. The steam is cut off in the small cylinder at from one fourth to two thirds of its stroke, according to the load, and is then farther expanded in the large cylinder.

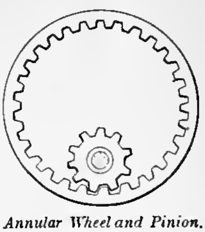
When working with the net power of 350 horses, the average consumption is 2¼ pounds of Welch coal per horse-power per hour, or 75,000,000 pounds of water raised one foot high with 94 pounds of coal. The duty of the engines has been as high as 87,000,000. See DUTY.

The Lynden and Cruquius engines work eight pumps, each of seventy-three inches diameter and ten feet stroke. The Leeghwater works eleven pumps of sixty-three inches diameter, ten feet stroke, each engine being calculated to lift sixty-six cubic meters of water per stroke.

The three engines are capable of discharging 2,000,000 tons of water in twenty-four hours at their full depth. They were erected by two English companies.

An'nu-lar Gear'-Wheel. A wheel whose teeth are on the concavity of an annulus, or ring, which is destitute of web or spokes.

Fig. 256.



Annular Wheel and Pinion.

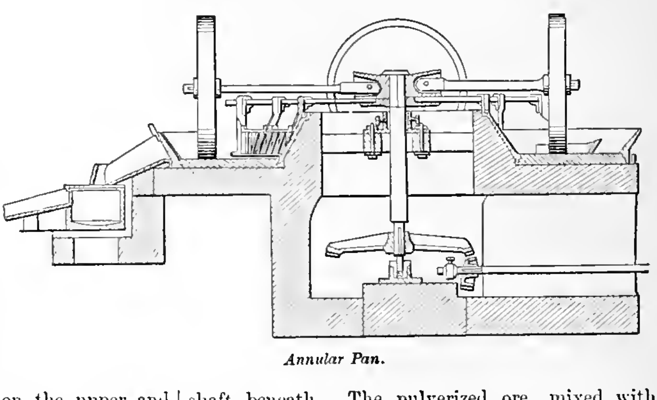
An'nu-lar Mi-crom'e-ter. A form of the circular micrometer invented by Fraunhofer of Munich, consisting of an annular glass disk whose central aperture is about half an inch in diameter and bounded by a metallic ring which is cemented to the inner edge of the glass.

The metallic ring is used to determine differences of declination between stars, from the differences of time occupied by them in traversing different chords of the ring. See CIRCULAR MICROMETER.

An'nu-lar Pan. A ring-shaped trough in which the vertical grinding-wheels of an ore-crusher revolve.

The main shaft may stand in a central aperture of the bed and receive motion from a horizontal

Fig. 257.



Annular Pan.

shaft beneath. The pulverized ore, mixed with water, is loosened up by rakes, and scraped from the sides to the wheel-tracks by knives. The wheels follow different tracks.

The pan form of amalgamator is a favorite, and several illustrations may be seen under AMALGAMATOR, Figs. 144–153, pp. 78–81.

An'nu-lar Saw. The annular saw for cutting pearl-button blanks is a steel tube with a serrated end.

The annular saw of the surgeon is the *trepan*, or, preferably, the *trephine*; which see. Other varieties of annular saws are known as *crown*, *barrel*, *drum*, or *cylinder* saws; which see.

An'nu-lar Valve. A gravitating-plate valve of a circular form and with a circular central aperture. It works upon a stem by the upward pressure of water, and closes an annular aperture when the lifting force is removed. See illustration in SCREW-PROPELLER STEAM-ENGINE.

An'nu-lat-ed Col'umn. A clustered column girt by bands.

An'nu-let. A flat molding; a small square member in the Doric capital.

An-nun'ci-a-tor. Annunciators are substitutes for the old-fashioned arrangement of bells in hotels, etc. Instead of each room being connected to a separate bell in the office of the hotel, the bell-pull of each room is connected to a single bell, which gives notice to the clerk or porter, and at the same time a pendulum with the number of the room is caused to vibrate, or the shield is removed from a number corresponding to that of the room. The devices are various. The general scheme is to connect the wire from the room to a numbered plate, which is moved up to an opening and thereby exposes its number to view. The wire at the same time trips a trigger which actuates the hammer of the bell. A variation in the mode of operation is found in those annunciators whose openings are all covered by pivoted shields, the numbers being permanently attached in the rear. The motion of the wire trips the sounding-hammer as before, and at the same time trips the shield to which it belongs, and causes it to oscillate from before the opening and expose the number to which it belongs. A crank operated by the hotel clerk restores the normal condition after the number has been observed.

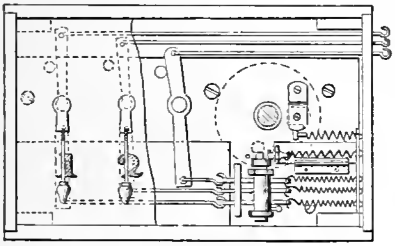
Horsfall, October 4, 1853, and Hale, April 22, 1856, are among the earlier inventors.

In Horsfall's, the wire from the room operates a rod whose horizontal lifting and tripping arm extends beneath its appropriate swinging index-plate. The rod and arm are arranged in such relation to the rocking-frame which carries the alarm-bell, that, as either of the rods is raised for the purpose of tripping one of the index-plates and exposing its number to view, the frame and bell will be also raised, and the pendulous hammer allowed to descend some distance. When the rod descends after tripping the index-plate, the rocking frame and bell also descend, and the contact of the short arm of the hammer with a lever causes the hammer to sound the alarm, subsequent to the exposure of the number.

The index-plates are thrown back to their covering position by an eccentric rod and connecting devices.

In the example annexed, a crank arm is attached to the center of the lever, and is acted

Fig. 258.

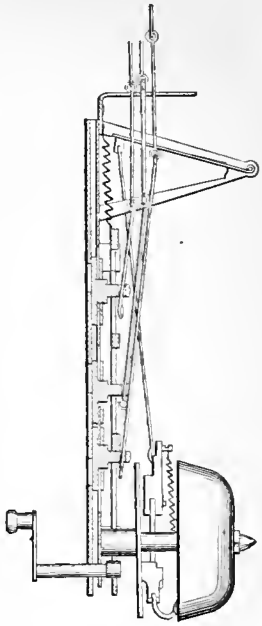


Hotel Annunciator.

upon by the wire, carrying a pendulum in front of the face of the annunciator, and by its vibration denoting the wire acted upon and the number of the room.

In Fig. 259 the annunciator is so arranged that the lifting of any wire shall not alone expose the number of the apartment, but shall lift a plate, and through the connecting wire cause the hammer to strike upon the bell. The slides, with the numbers upon their faces, have projections on their rear with holes through which the wires pass, and the upward movement of the slides is limited by transverse bars above them, which cross the line of their motion.

Fig. 259.

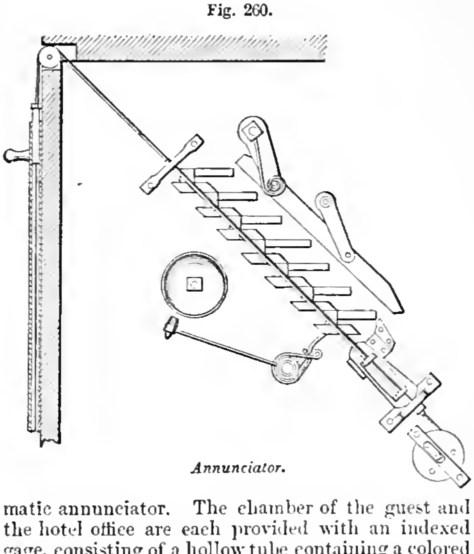


Annunciator.

The mechanism in Fig. 260 is so arranged and connected with a knob in the room of a hotel, that as the knob is actuated by the occupant a bell will be sounded at the office, and a slide moved which discloses the name of the article wanted, such as "water," "boots," "messenger," etc. A slide in the room is made to cover the names of articles generally wanted by a guest, and corresponds with a similar slide and names in the office. The extent of the pull determines what name shall be exposed, and the guest, by noticing the effect at the *pull* end, may determine the effect at the other end, as the slides are coincident.

Another form is a combined hydraulic and pneu-

Fig. 260.



Annunciator.

matic annunciator. The chamber of the guest and the hotel office are each provided with an indexed gage, consisting of a hollow tube containing a colored liquid. At the back of each tube is a graduated index marked at intervals, "fire," "light," "water," "brandy," "towels," etc., as may suit the average of customers. The respective tubes are connected by an air-pipe, into which air is injected by the guest, to raise the liquid in the respective tubes to the point which indicates his wants.

An′ode. That pole of the galvanic battery by which the electricity *enters into* the substance suffering decomposition ; the positive or + pole. This nomenclature was adopted by Professor Faraday.

A-nor'tho-scope. The name given by M. Plateau of Brussels to an instrument invented by him and intended to produce a peculiar kind of anamorphosis by means of two disks rotating rapidly one before the other; the hinder one is transparent and bears distorted figures, while the front one is opaque and is pierced with a number of narrow slits. On revolving the disk the distortions appear as amusing and interesting figures and pictures. As in other toys of a similar kind, the effect depends upon the persistence of impressions on the retina. — *Brande.* It probably suggested the *Zoetrope*, which has lately become so popular in the United States. See THAUMATROPE; PHENAKISTOSCOPE; STROBOSCOPE.

An'sæ. (*Artillery.*) The handles of some kinds of brass ordnance.

An'ta. (*Architecture.*) A pilaster occurring at the corner of a flank wall.

An'te-fix'æ. (*Architecture.*) *a.* Ornaments placed below the eaves of a Grecian temple; perforated to allow the escape of water from the roof.

b. Blocks covering the termination of the ridge formed by the overlap of the tiles on a Grecian roof.

An'te-mu'ral. (*Fortification.*) An outwork consisting of a high, strong wall with turrets, for the defence of a gate.

An-ter'i-des. Buttresses.

An'te so-la'ri-um. A balcony facing the sun.

An-te-ven'na. An awning, or shade roof.

An'tho-type. A photographic process in which the colored juices of the wild poppy, rose, stock, etc., are effaced by the action of light.

An'thra-cene. A solid crystalline hydrocarbon, accompanying naphthaline in the distillation of coal-tar.

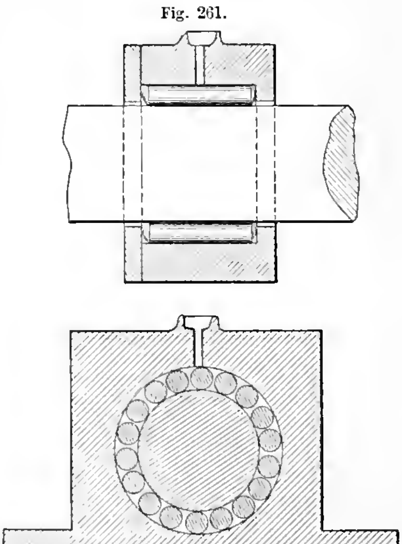
An-thra-com'e-ter. An instrument for measuring the amount of carbon in a given case. — *Beil.*

An'ti-at-tri'tion Com'pound. For the bearings of machinery and axles of carriages. See LUBRICANT; ALLOY; ANTI-FRICTION COMPOSITION; ANTI-FRICTION METALS.

An'ti-cli'nal Line. (*Mining Engineering.*) The axis of curvature on the arch or saddle of a range, on each side of which the strata dip. Opposed to *Synclinal.*

An'ti-fric'tion Bear'ing. A rolling bearing for an axle or gudgeon. The intention is that the parts primarily in contact shall not rub against each other, but move in unison. In one form the roller surfaces impinge upon the surfaces of the axle and its box (Fig. 261); in another form the rollers are on axles (see Fig. 263). A familiar illustration is also found in the improved form of hanging grindstones (see Fig. 265).

Fig. 261.

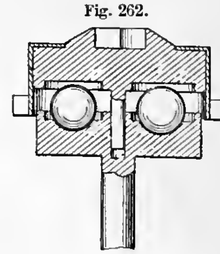


Anti-friction Bearing.

The "Palier Glissant," of Girard, consists of a journal box whose lower part is grooved and has an aperture communicating with a pipe through which water under a heavy pressure is introduced beneath the journal. The effect of this is to slightly lift the journal, allowing a very thin film of water to escape, which effectually lubricates the bearing, entirely preventing contact of the metallic surfaces.

This is analogous to the hydraulic pivot for turbine wheels, invented by the same engineer, in which the weight of the turbine and its vertical shaft is supported by a water cushion, in the same manner as is the horizontal axis in the former case.

Fig. 262.



Anti-friction Box.

An'ti-fric'tion Box. An enclosure for the balls or rollers of a step or bearing.

An'ti-fric'tion Com-po-si'tion. A lubricating material or compound to diminish friction of parts moving in contact. The compounds are numerous, and include the following materials in various combinations: —

Alloys. See ANTI-FRICTION METALS.
Alum.
Asbestus.
Bitumen.
Borings of Metal.
Cork.
Cotton.
Fiber, Animal.
Fiber, Vegetable.
Gelatine.
Graphite.
Gum.
Gypsum.
Lard.
Lime.
Mucilage.
Oils of various kinds.
Pasteboard saturated with petroleum.
Pith.
Plumbago.
Sal-ammoniac.
Shavings of wood.
Silicate of soda.
Steatite.
Sulphur.
Talc.
Tallow.
Tannic acid.
Wood saturated with oil.
Wool flock.

An'ti-fric'tion Met'als. Alloys principally used for bearings of machinery and for journal boxes. Several are described under the head of ALLOY.

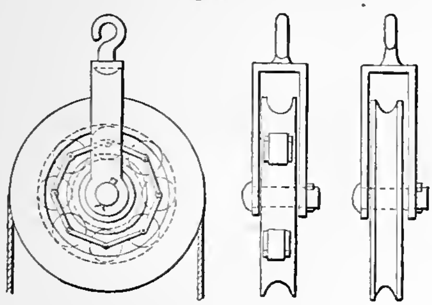
Some variations are found in the formulas, comparatively few agreeing even in the composition of Babbitt's metal, patented in 1839, and so much used throughout this country and in Europe. The following table will give the composition of several: —

	Tin.	Antimony.	Copper.	Zinc.	Lead.	Iron.	Arsenic.	Glass.	Borax.	Sulphur.	Pruss. Potassa
Babbitt's	50	5	1								
Another formula	10	2	1								
Fenton's	10		10	10							
Belgian, for objects exposed to friction	4	0 5	20		0.25						
" exposed to shocks	1		20	6							
" exposed to heat	0 5		17	1	0 25						
Dinsman's			16		8			4	1		0.5
Richardson's	2		62	34		1	1				
Strubing's	18	2.5		75	4.5						
Engl. Pat. 896 of 1862	40		28	136		2	1			1.5	

An'ti-fric'tion Press. A press in which the power is obtained by the rolling of two cams against an intermediate roller. See ROLLING-CAM PRESS.

An'ti-fric'tion Pul'ley. A device for the purpose of lessening the friction of the sheave on its pin. An annular system of anti-friction rollers surround the pin, and rotate on their own axes as they revolve on the pin. They are maintained at their

Fig. 263.

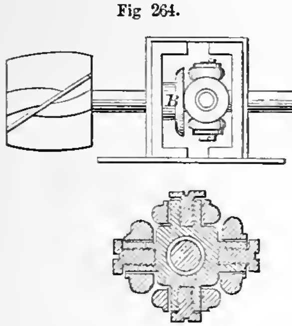


Anti-friction Pulleys.

proper relative distances by a ring or series of links, so that the faces of the rollers themselves do not come in contact, as contacting faces, under these circumstances, would be revolving in different directions, and great friction would result.

An'ti-fric'tion Step. A bearing at the end of a rotating shaft, to diminish the friction of the contact with the step when pressure is applied longitudinally. In the step for propeller shafts, the loose collar *B* has anti-friction wheels on radial axes, which act between a collar on the propeller shaft and a fixed plate traversed by said shaft. The object is an anti-friction bearing to take the *end* strain of the shaft.

Fig 264.



Anti-friction Step.

A somewhat similar arrangement is used for vertical shafts in some cases. See Fig. 262.

An'ti-fric'tion Wheel. The wheels *C C'* form a rolling bearing for a shaft, so as to diminish its friction thereon; the bearings for the axis of a grindstone, for instance, as shown in Fig. 265. Analogous devices are found in many machines and in carriages. See JOURNAL BEARINGS; AXLE.

An'ti-gug'gler. A small tube, inserted into the mouth of a bottle or carboy to admit air while the liquid is running out, and thereby prevent guggling or splashing of corrosive liquid.

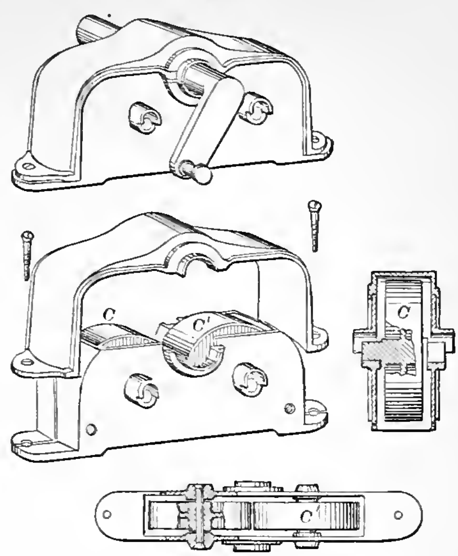
An'ti-in'crus'ta-tor. A device or a composition to prevent the incrustation of steam-boilers.

One class of improvements in this line is magnetic; it depends upon keeping up an electric action which prevents the adherence of the scale of salts of lime, etc.

Another class consists of mechanical agents, and a third of chemical. See INCRUSTATION IN BOILERS.

An-tim'e-ter. An optical instrument for measur-

Fig. 265.



Anti-friction Wheels.

ing angles. A modification of Hadley's Quadrant, long since superseded by superior instruments.

An'ti-mo-ny. Equivalent, 129.03. (Symbol, Sb: Stibium.) Specific gravity, 6.8. Melts at 995.5, Fah.; passes off in vapor at a white heat. It has a peculiar taste and smell. It is a bluish-white, brittle metal, and is much used in hardening type-metal, to which it also imparts the faculty of not shrinking in cooling. It enters into the composition of some other alloys, such as one kind of speculum metal.

Its salts are much used in medicine and pyrotechnics.

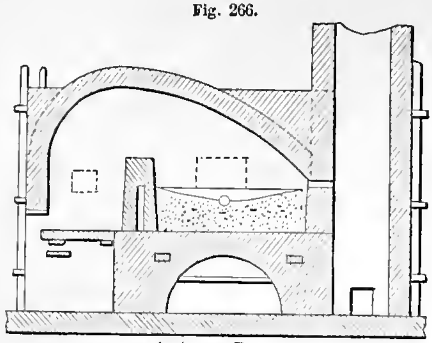
Antimony was known to the Hebrews as a cosmetic. With it, it is supposed that the wicked Jezebel painted her eyelids and eyebrows, B. C. 884, just before she was thrown out of window by the orders of the cruel Jehu, who trod her under the feet of his horse, and left her to be devoured by dogs.

The Arab women use *kohl* to increase the brilliancy of the expression of their eyes, as the Hebrew women did down to the times of Jeremiah and Ezekiel, and later. It is yet an Oriental custom. Little toilet boxes and bottles for kohl are found among the relics of the ancient Egyptians, and are preserved in many collections; for instance, in the Abbott Collection in the possession of the Historical Society of New York.

Basil Valentine introduced the metal antimony into the practice of medicine. Observing that some swine fattened surprisingly quick after the administration of the drug, he tried it on some of the monks in his vicinity, who had become much attenuated by their Lenten fast. The account says that they were all killed, and hence the name *Anti-moine*. It was previously called *Stibium*, and yet retains that title in scientific nomenclature.

An'ti-mo-ny Fur'nace. The antimony furnace, Fig. 266, as at present used, is a reverberatory whose hearth is formed of clay and sand solidly rammed together and sloping from all sides towards the middle, at which place is the discharge opening, temporarily closed with coal-ashes. The air channel passes up through the fire-bridge, and the fire

Fig. 266.

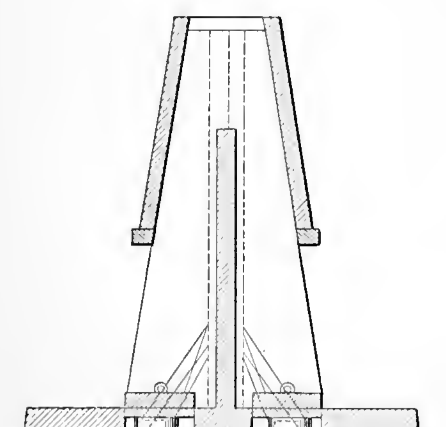


Antimony Furnace.

is in the chamber at the end, the flame reverberating in the chamber above the ore. The charge is introduced at the usual opening, which is closed by a door while the operation is in progress. The slag is drawn off at the same opening. The sulphuret of antimony is found associated with gangues of quartz, sulphate of barytes, and carbonate of lime, and is easily fused therefrom by the application of heat in the furnace described. It is not obtained perfectly pure therefrom, but is fused again under coal-dust in crucibles on a reverberatory hearth.

The former mode of obtaining the metal from the ore consisted in exposing it in luted crucibles which are placed in a furnace (Fig. 267). The crucibles have openings in the bottom, and are luted to a

Fig. 267.



Antimony Crucible.

perforated tile which forms the roof of a lower chamber containing a pot into which the metal escapes as the operation proceeds. The gangue remains in the crucible above. This method is found to be very destructive of crucibles.

The crude antimony is purified by repeated exposure at moderate heats to expel the sulphur and fuse the metal. The difficulty in the treatment arises from the volatility of the metal, which escapes if excess of heat be applied. This is in the domain of chemistry.

The ordinary alloys of antimony are: —

	Antimony.	Lead.	Tin.	Copper.	Bismuth.
Type Metal	1	4			
Stereotype Metal	1	6			
Music Plates	1	1	1		
Britannia Metal	8		100	2	2
Pewter	1		12		

An'ti-qua'ri-an. A size of drawing-paper measuring $52\frac{1}{2} \times 30\frac{1}{2}$ inches, and weighing 233 pounds to the ream.

An-tique' [an-teek']. (*Type.*) A fancy style in which each stroke of the face has an equal thickness. There are many varieties.

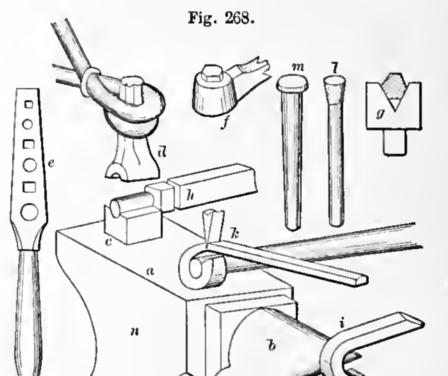
An'ti-sep'tic. See Wood, Preservation of; Food, Preservation of.

An'vil. (*Forging.*) 1. This is ordinarily a mass of iron which sustains a piece of metal while the latter is being forged to shape. In its ordinary form, where the hammer is worked by hand, it has a square central block, and a strong, projecting, and pointed piece of steel called the *beak* or *horn.* The *quarter* has holes for tools such as cutters and swages, and the whole is mounted on a block. Isaiah speaks (xli. 7) of him that smites the anvil in connection with the art of the goldsmith, and also refers to the subsequent soldering.

In heavy operations, such as the forgings of heavy ordnance and shafting, the anvil consists of an enormous iron block imbedded to a considerable depth and founded on piles or masonry.

Fig. 268 shows the ordinary blacksmith's anvil,

Fig. 268.



Anvil and Tools.

and illustrates the methods of making bolts.

a face of the anvil.
b horn or beak.
c hardy hole, with rounding-iron inserted.
n body or web of the anvil.

In forming a bolt by the *drawing-down process,* the size of the bar of iron is reduced at proper intervals by fullers, and the operation is completed by the rounding-irons, shown at *c* and *d*, leaving the head of the full size of the bar *h*, which is then cut off with a chisel.

In *upsetting*, the body of the bolt remains of the full size of the bar, while the head is enlarged by upsetting, that is, driving the end down upon the body with a hammer, thus forming an enlargement; or it is enlarged by *jumping*, that is, beating the heated end forcibly on the anvil; in either case, the head of the bolt is finished by means of the heading-tool, two varieties of which are shown at *e* and *f*.

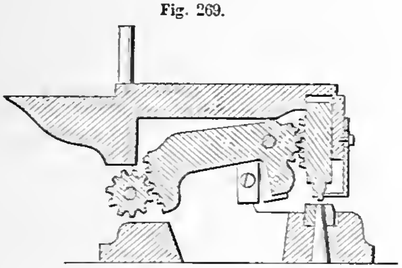
The third process of bolt-making is by welding or *building up;* a bar of flat iron is bent around the horn of the anvil, as shown at *i*, and the bar of round iron intended to form the body is inserted through it; the ring is then cut off at the proper length by the chisel, shown at *k*, and the head finished as usual. *g* is a swage for forming hexagonal heads to bolts, or other hexagonal or triangular forms, and *l*, *m*, represent bolts. in the first of which the head is partially made, and in the latter completed.

Tubal Cain, the descendant in the sixth generation of Cain, is the first recorded blacksmith, and the necessities of his craft must have introduced the anvil before the time of Cinyra of Cyprus, who is credited with the invention by Pliny.

The anvil of the Greeks and Romans (*incus*) was usually of bronze, and was shaped like our own. It had a horn, and was mounted on a wooden block.

Among numerous varieties of anvils for special trades, and to give a more extended usefulness to the space occupied by the implement, may be cited one in which a shears and punching-machine are com-

Fig. 269.

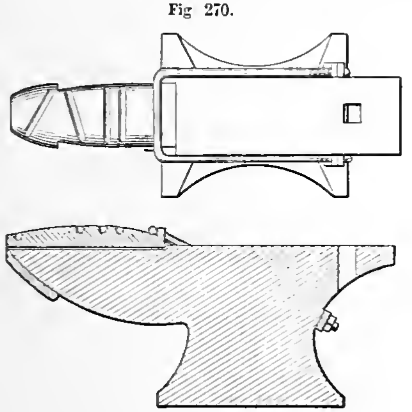


Anvil Shears and Punch.

pactly placed beneath the anvil, and are worked by handcrank, pinions, and segment-rack.

Another anvil has a secondary horn, is socketed upon the beak of the anvil, and confined there by a hinged link. On the upper surface of the secondary horn are grooves into which the shoe is driven

Fig 270.

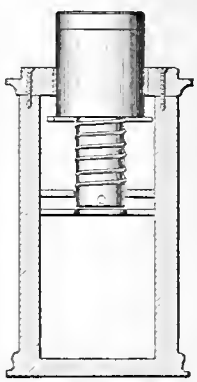


Anvil.

so as to bevel the inner edge, to facilitate its freeing itself from snow which becomes packed inside it.

In Fig. 271 the anvil is supported by a stout spring, whose recoil is partially counteracted by the light springs above. The object is a certain amount of resiliency without jar as the anvil regains its normal position.

Fig. 271.



Spring Anvil.

The gold-beater's anvil, when using the forging-hammer, is a block of steel, four inches long, and three broad. The *ingot* is reduced by this operation to a thickness of one sixth of an inch.

The anvil used in the subsequent operation is a block of black marble twelve inches square at top, and eighteen inches deep, framed in a wooden block.

Anvils are tempered in a *float*, instead of being merely dipped. The rapid formation of steam keeps the water from close contact with the metal, and in the *float* a copious stream of water is poured upon the surface to be hardened, falling particularly upon the center of the face.

Large anvils are slung from a crane into a tank beneath a fall of water, where they are hardened; being lifted before the main bulk of the iron is cooled, the remaining heat is allowed to draw the temper to the right degree, when the anvil is instantly immersed.

The casting of an anvil weighing 358,000 pounds is thus described by the "London Engineer": —

"Another immense casting has been turned out by the Midland Works, Sheffield, viz. a 160-ton anvil-block for a steam-hammer. In the center of the floor a great pit was dug, and in this the mold was formed, the anvil being cast with its face downward. The mold was 12 feet square at the base, and 11 feet 6 inches deep, and it was estimated that nearly 170 tons of iron would be required to fill it. At intervals outside the shop were five furnaces, and at six o'clock in the morning these commenced to pour their molten contents into the huge chasm, and continued until about five o'clock, when the operation was declared to be successfully completed. From four or five different points streams of liquid fire were slowly rolling to the edge of the pit, where they fell amidst showers of starry sparks into the vast mass beneath. A metallic rod was thrust through the mass to test its perfect liquidity, and, this having been satisfactorily proved, the top of the pit was carefully closed, to be opened no more until the metal has cooled, which will probably be in about seven weeks. The anvil is intended to be placed in a gun-manufactory in the vicinity. The bed consists of a first course of great piles, which have been driven by steam-power 15 feet into the solid ground. Upon these is a thick bulk of oak, solidly braced and bolted together, and the combined mass forms the bed of the anvil. Only about half a foot of its bulk will appear above ground. The block will have to sustain the blows of a 25-ton steam-hammer which will be employed in forging 600-pounder and 300-pounder guns for Mr. Whitworth."

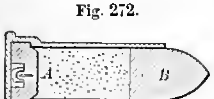
Mr. Ireland, of Manchester, England, has a portable plant for casting large anvil-blocks in the position they are to occupy on the premises where they are to be used. He furnishes everything but the iron and the blast.

"The plant used at Mr. Bessemer's works consisted simply of a cupola 4 feet in diameter within the lining, and 12 feet deep to the charging-door, constructed on the "upper tweer" principle. A belt about 2 feet 9 inches deep surrounds the cylinder at about 7 feet from the ground, and into this belt the blast is delivered by two large pipes, one on either side. The upper row of tweers consists of sixteen orifices, each about 3 inches in diameter, ranged equidistantly above the level of the main supply pipes, which discharge into the lower portions of the belt. The lower tweers are only four in number, each about 8 inches in diameter, disposed opposite each other, but not opposite the main pipes. By this means the blast is very equally distributed through all the tweers. At the time of our visit, this cupola was bringing down 9 or 10 tons of iron per hour, and Mr. Ireland has recently cast an anvil-block, weighing no less than 205 tons, at the Bolton Iron and Steel Works, at the rate of 25 tons per hour, with two cupolas precisely similar to the one under consideration. The consumption of coke is very moderate, when once everything is well warmed up, not greatly exceeding one cwt. of coke per ton of iron. A strange contrast exists between such operations as this and those in which Mr. Ireland first engaged in the year 1809, when he, in common with many other founders, considered it a good day's work to melt a single ton of iron in ten hours.

"It is not easy to see how the casting of large masses can be more economically effected than under this system. The lining of the cupola being removed, it is brought into the condition of an ordinary boiler shell of no very excessive weight, easily admitting of transport by either rail or water. The whole affair being carried out by contract, the manufacturer is saved an immense amount of trouble and responsibility, while all the operations being conducted by those who possess a special knowledge and experience of the matter in hand, the best results are sure to be obtained at the least possible outlay. In many cases, without the existence of such a system, the manufacturer would find himself compelled to erect a cupola of large dimensions for which, the block once cast, he would have no further use." — *London Engineer*.

2. In the Laidley cartridge (Fig. 272) is an *anvil-plate* *A* which is held in position by a shoulder *d* on the capsule. On the plate is a nipple which holds the percussion-cap, and the latter is exploded by a blow on the rear, delivered by the nose of the gun-lock. *B* is the bullet retained by spinning down the edge of the capsule.

Fig. 272.



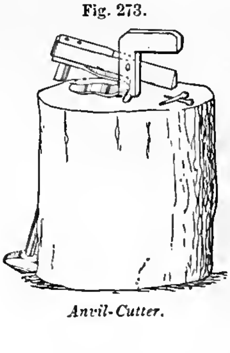
Cartridge Anvil.

3. A little pennon on the end of a lance.

An'vil-cut'ter. A shears operated by a blow of a hammer, for the use of blacksmiths.

The lower cutter is upon one end of a lever whose other end is elevated by a spring to open the jaws. The jaws are closed by a blow of the hammer upon the ou er end of the lever.

Fig. 273.



Anvil-Cutter.

A-or'tic Com-press'or. An instrument for compressing the aorta to limit the flow of blood from thence to the divided femoral artery in cases of amputation at the hip joint. See *Surgeon-General Barnes's Report, Circular No. 7.*

Ap'er-ture. 1. (*Architecture.*) An opening in a wall or partition, for a window, door, ventilation, or to form a recess.

The sides are *jambs.*

The top is the *head,* or *lintel.*

The bottom is the *sill,* or *threshold.*

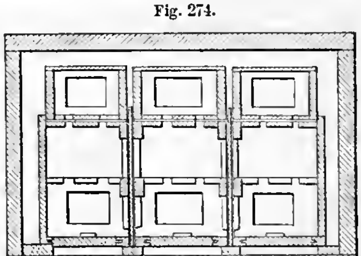
2. (*Optics.*) The orifice in the end of a telescope or other optical instrument through which light enters. The diameter of the exposed portion of the object-glass ; as, "6-inch aperture."

Aph'lo-gis'tic Lamp. Literally, *flameless.* A lamp in which the wick, of platinum wire, is kept constantly red-hot by the slow combustion of alcohol, heated by the wire itself.

A'pi-a-ry. A place where bees are kept. It generally assumes the form of a house forming a common shelter for the hives, but in some cases the hives are more closely associated and form a cluster of families, occupying a bee "palace." This is frequently an ornamental structure with a number of apartments for brood comb, and outlying, removable boxes for containing surplus honey. The interior has provision for ventilation by gauze-lined tubes, and the portions communicate by ducts, or by holes in the partitions. Provision is made for parting off certain portions which are removable with their tenants and provisions to form a nucleus for another cluster of families. The intention of the bee-palace arrangement has been to give the bees the advantage of combined effort and at the same time prevent natural swarming by making colonies removable. Experience indicates that they run well for a season and then dwindle, becoming a prey to their natural enemies, among which the most fatal is the bee moth. Individual families are comparatively short-lived, and modern apiarists have obtained such a command over the fraternity, that the families may be divided at pleasure, with a frequency and success dependent upon the resources of the bees for food and the salubrity of the season, always bearing in mind the tribal economy of the bees, which requires the presence of a queen.

In some parts of the world the apiary consists of a collection which are formed into a village with avenues. They are sheltered in winter-quarters, and on the approach of spring are carried out to favorable localities, where they work during the honey-making season. This is especially the case on some parts of the continent of Europe, where bee-keeping is systematized and followed as a regular branch of industry, the aim being to glean the favorable territory of all the bee-supporting nutriment.

Fig. 274.



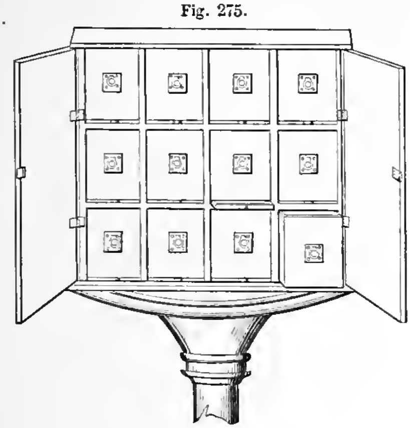
Apiary.

The devices in apiaries, not considering those belonging to hives, which are considered separately (see BEEHIVE), are for ventilation, protection against storms and depredators, and for housing during winter.

In the compound hive (Fig. 274) the apartments are associated side by side in an outer case, and communicate with each other laterally, and each with its removable honey-box above. This is an illustration of the lateral arrangement; others are associated vertically.

In Fig. 275 is shown another form of apiary whose "pigeon-holes" are occupied by drawers which are interchangeable and made to communicate as required. Doors inclose the front, and the whole is mounted on a pillar to raise it out of the way of mice, etc. Ventilating arrangements are made in the interior, the ramifications extending to the pockets which contain the drawers forming the apartments. An ornamental character is given to the whole to make it an agreeable object in a bower or on a grass plat.

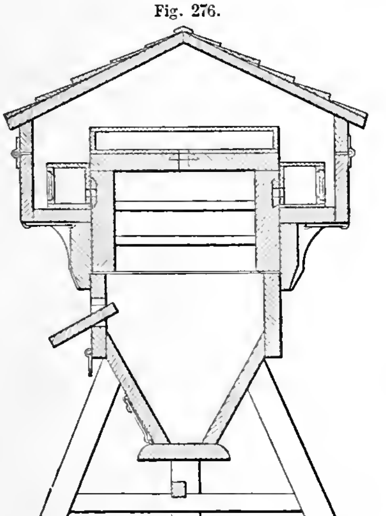
Fig. 275.



Apiary.

Another bee-palace has a frame on which the hives are supported, shelves for honey-boxes, doors for examination or change, and an enclosing shed above for protection from heat and wet. The lower part of the case has inclined sides and a falling door at bottom for the discharge of offal.

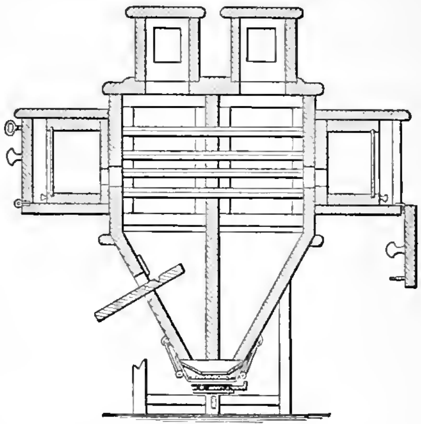
Fig. 276.



Bee-Palace.

In Fig. 277 the moths and grubs falling from the hives are directed, by the inclined sides of the lower portion, into the trap beneath. The trap has a funnel-shaped conductor, a perforated diaphragm, and a detachable bottom by which the insects and offal are removed. Additional apartments for the extension of room are added above and on the sides, and admittance to them is afforded as required by withdrawing the slides which command the ducts of communication.

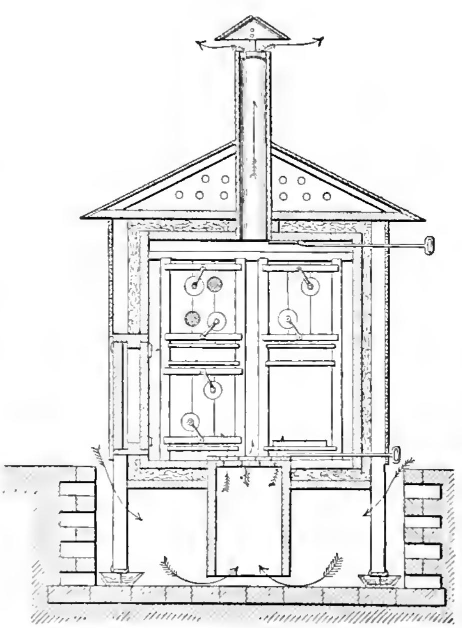
Fig. 277.



Bee-Palace.

Fig. 278 shows a hive which has a sunken hatch-

Fig. 278.



Apiary.

way in the center, extending into a pit so as to bring the floor of the hive about on a level with the surface of the ground. The walls and ceiling are double, and have a layer of non-conducting material. A central chimney removes the vitiated air, and registers determine the admission of air to each hive in the group. It is supported by posts which rest in cups of water to prevent access of ants and mice. The devices have particular reference to means for maintaining an even temperature ; the double sides and non-conducting material obstructing the passage of heat outward in winter, and also moderating the effect upon the bees of the summer heat striking upon the sides of the hive. The equality of the temperature is also conserved by the nearness of the ground, while provision is made for removing effluvia or corrupt air which might accumulate in the pit.

Ap′la-nat′ic Lens. A lens constructed of different media so as to correct the unequal refrangibility of the different rays.

The object to be attained is that rays parallel to the axis of the lens or diverging from a point on its axis, after passing through it and suffering refraction at its surface, shall converge to a single point, the true focus. See ACHROMATIC LENS.

A-pol-lon′i-con. A large chamber-organ played by key-boards or by barrels, and exhibited in London some years since. It was constructed by Flight and Robinson in 1817. It had 1,900 pipes, 45 stops, 5 key-boards and 2 barrels. The number of keys acted upon by the cylinders was 250.

Ap′o-me-com′e-ter. An instrument for measuring hights, invented by a Mr. R. Millar, and manufactured in London.

The apomecometer is constructed in accordance with the principles which govern the sextant, viz. : As the angles of incidence and reflection are always equal, the rays of an object being thrown on the plane of one mirror are from that reflected to the plane of another mirror, thereby making both extremes of the vertical hight coincide exactly at the same point on the horizon glass, so that by measuring the base-line we obtain a result equal to the altitude.

The eye of the observer when in position will be at the lower end of the hypotenuse, and the summit of the object at the other. Keeping the line of vision, which forms the base, exactly horizontal, the observer approaches the object till the images coincide, when the base will agree in length with the perpendicular, and the measured length of the former will give the hight of the latter.

A-poph′y-ges. A molding of a rounded concave form. See MOLDING.

A-pos′tle. (*Nautical.*) A knight-head or bollard-timber where hawsers and heavy ropes are belayed.

A-pos′tro-phe. An elevated comma-shaped point ('), to indicate an abbreviation, as "don't" for "do not" ; to mark the plural of figures or letters used as words, as "two 20's," "the font lacks A's" ; or to mark the possessive, as "Iago's trick."

Ap′pa-ra′tus. 1. A set of tools or implements for a given duty, experimental or operative.

2. A complex instrument or appliance, mechanical or chemical, for a specific action or operation.

3. (*Nautical.*) A ship's war equipage and ammunition.

Ap-par′el. 1. Body clothing.

2. (*Nautical.*) The masts, rigging, sails, and other gear of a vessel.

Ap-pend′a-ges. (*Shipbuilding.*) Relatively small portions of a vessel projecting beyond the general shape, as shown by the cross-sections and water-sections. These parts usually consist of, —

The keel below its rabbet.

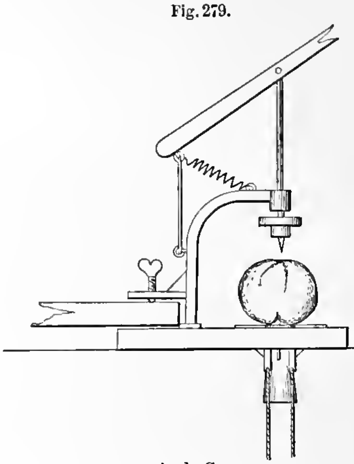
Part of the stem and stern-post.

The rudder, rudder-post, and screw (if any).

These volumes are calculated separately and added to the main part of the displacement.

Ap′ple-cor′er. Many of the apple-parers have attachments for dividing the fruit into quarters, or still more minutely ; in some cases the apple is pushed from its impaling fork against a cutting-tube with radial knives, the tube receiving the core and the knives making the division. A device for coring, slicing, and stringing fruit is shown in Fig. 279. The fruit is placed above the coring-tube and its radial knives, and is pressed down upon the

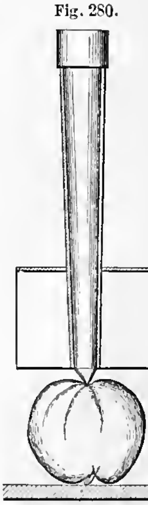
Fig. 279.



Apple-Corer.

same by a plunger whose central part projects sufficiently to drive the core into the tube. The quarters are pressed upon sharp plates which enter the fruit a short distance, and are the means of introducing strings which depend from the said plates ; the successive pieces push their predecessors off the plates, and the pieces are thus strung and suspended until a sufficient quantity is gathered. The strings are then removed and empty ones attached.

Fig. 280.



Apple Corer and Quarterer.

Fig. 280 is an example of an implement consisting of a tube or circular cutter of sheet metal, slightly tapering from the cutting edge, and with four or more radial cutters projecting from its circumference. The central plunger serves as a guide in applying the implement, and is afterwards the means of ejecting the core.

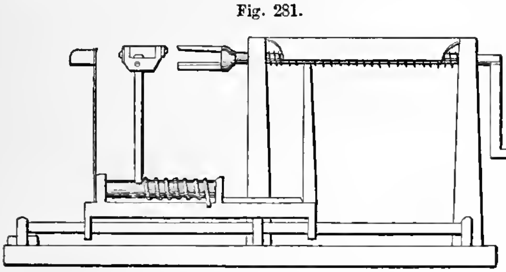
Ap′ple-par′er. This is an ingenious American device, and created mingled emotions of admiration and amused surprise when it was introduced into England ; the date is not remembered, but it was referred to as a novelty about 1840. There are now over eighty patents, which appear to agree in one respect, that is, the rotation of the fruit on the end of a fork. The operation requires two motions, which vary in the different machines.

1. The cutter describes a semicircle in the plane of the axis of the fork while the fruit is rotating, so that it may remove a paring from the stem to the blossom end, following the rotundity of the fruit.

2. An oscillatory motion is given to the fork, whose stock describes an arc in the plane of its length, presenting the rounded surface of the rotating apple to the knife, which cuts a continuous paring from the fruit, from the stem to the blossom end.

The first patents recorded are those of COATES, 1803, and CRUTTENDEN, 1809; GATES added the quartering in 1810. The Patent-Office records perished in the fire of 1836. We find that in MITCHEL's patent, April 13, 1838, the first granted after the fire, that the knife was operated by hand while the fruit was impaled upon a fork which was rotated by gearing. The pared apple was then pushed through an opening with a cruciform knife arrangement, by which it was quartered.

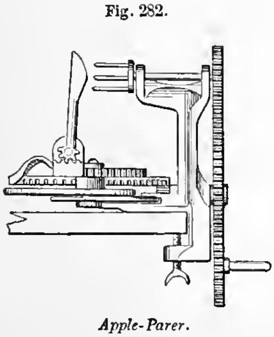
Fig. 281.



Apple-Parer.

In Fig. 281, date of 1857, the threaded shaft draws the slide, bringing the paring-knife against the surface of the apple which is impaled on the fork. The knife-stock is so pivoted on its shaft as to present the blade to the apple while following its convexity to some extent. The work is not so thoroughly done on the ends as by later inventions in which a positive semicircular sweep is given to the fruit or knife. The slicing-knife, which follows the parer, cuts the apple into a spiral, leaving a cylindrical core-piece attached to the fork. In a later machine, cams on the main and an intermediate wheel combine to oscillate a rack, which sweeps the paring-knife alternately from the stem to the calyx of one apple, and in a contrary direction on the next. The device is attached by a clamp to the table.

Fig. 282.

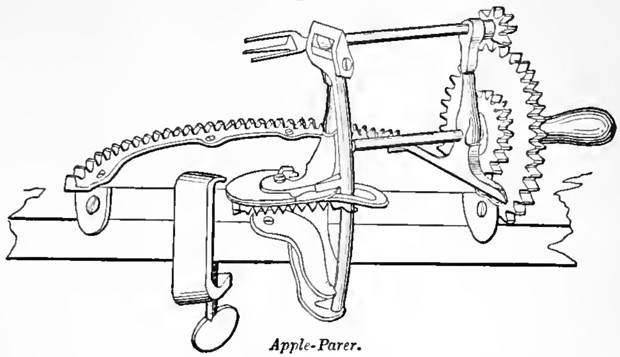


Apple-Parer.

In Fig. 282, the apple is impaled on the revolving fork, and the knife is made to sweep around automatically, as its platform is revolved by gear connection with the hand-crank shaft. The knife returns automatically to the place of commencement after making its effective sweep.

In Fig. 283 the rotation of the fork is obtained by one motion of the hand in an arc of a circle, the smaller cog-wheel on the main shaft gearing into the curved rack and moving the larger cog-wheel which runs the pinion on the fork-shaft. The paring-knife and its stock have no motion on each other, but have such a progressive and rotary movement, that, as the apple is revolved, the knife will pass from the stem to the blossom end of the apple, and adapt itself to the varying form and inequalities of the fruit being pared. The knife is automatically moved away from the fruit after the effective sweep, and resumes its operative position when returned to the starting-point.

Fig. 283.

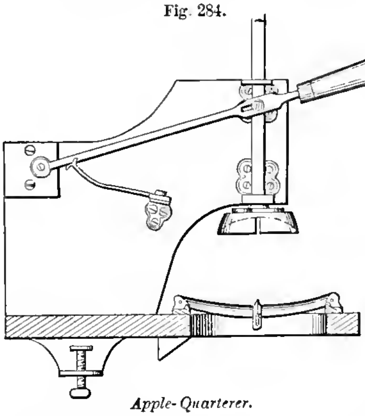


Apple-Parer.

Ap'ple-quar'ter-er. An implement for dividing apples into quarters.

A wooden plunger is pressed down upon the apple placed on a central point, and forces it between the four knives. In another form it is a coring-tube with four radial wings.

Fig. 284.



Apple-Quarterer.

Ap'pli-ca-tor. A surgical instrument, of form and proportions adapted to its specific uses, for applying caustic, a tent, or other application to a deep-seated part.

Ap-point'ments. 1. (*Personal.*) Accouterments other than arms and ammunition.

2. (*Naval.*) The furnishing or equipment of a ship.

Ap-proach′. In a military sense, either a route by which a fort, fortified town, or other military position, may be approached for the purpose of attack; or the trench or protected road constructed by the besiegers for conveying ordnance, ammunition, and stores, or for marching bodies of men to or from the parallels; in the latter case approaches may be either excavations, with the earth therefrom thrown up as an embankment on the side exposed to the enemy's shot, or they may be formed of sand-bags, gabions, fascines, or anything, in short, which will stop a cannon-ball. The works of this kind constructed during the siege of Sebastopol in 1854 and 1855 are probably without a parallel in modern history, if indeed they were ever equalled in the history of sieges. They embraced seventy miles of sunken trenches, and no less than sixty thousand fascines, eighty thousand gabions, and one million sand-bags were employed to protect the men working in the trenches and at the different batteries.

A′pron. 1. A board or leather which conducts material over an opening; as, the grain in a separator, the ore in a *buddle* or *frame*, etc.

2. The sill of a window or a dock entrance.

3. The floor of a *tail-bay*. See CANAL LOCK.

4. A leaden plate over the vent of a gun.

5. A leathern covering for the legs of the person occupying the driving-seat of a vehicle.

6. The piece that holds the cutting tool of a planer.

7. (*Plumbing.*) A strip of lead which leads the drip of a wall into a gutter; a *flashing*. See GUTTER.

8. (*Shipbuilding.*) A timber within the stem of a vessel in prolongation of the *dead* wood. It strengthens the stem, and affords wood for the reception of the plank of the bottom and the heels of the foremost timbers. See STEM.

A′pron-piece. (*Carpentry.*) A horizontal piece supporting the upper ends of the *carriage-pieces* or *rough-strings* of a wooden staircase.

A *pitching-piece*. The *carriage* which supports the steps is *pitched* or slanted against it.

Apse, Ap′sis. (*Architecture.*) *a.* The arched roof of a house, room, or oven.

b. The domed semicircular or polygonal termination of the choir or aisles of a church, where the altar was placed and where the clergy sat, in Gothic constructions.

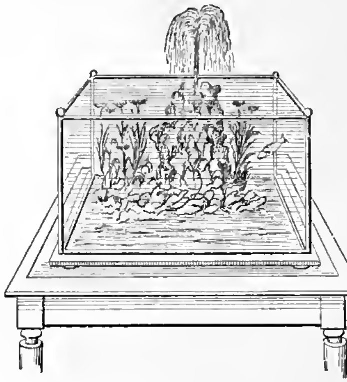
A-qua′ri-um. A vessel containing salt or fresh water in which living specimens of aquatic animals and plants are maintained; sometimes called *vivarium* or *aqua vivarium*. From the earliest times animals living in water have been kept alive in small vessels for exhibition or transportation by frequently changing the water, yet it is only since the rise of modern chemistry and physiology that the true principles of the aquarium have been discovered.

As the air contained in the water is breathed by the animals and loses its vitality, the resulting gaseous product becomes deleterious and must be removed: this is the office of the plants in the modern aquarium; these restore the oxygen and abstract the excess of carbonic-acid gas, their function in the subaqueous vegetation being similar to that performed by the ordinary terrestrial flora.

But, besides the animals and plants properly proportioned to each other to maintain the uniform composition of the air in the water, it has been found necessary to add certain animals which feed on decomposing vegetable matter and act as the scavengers in this community; such are the various species of molluscous animals, as the snails, etc. It is of importance to guard against the preponderance of animal life, for an excess of animals over plants in a given space will disturb the balance and lead to their destruction. The demonstration of these conditions is due to R. Warrington, 1850. In some cases where the supply is continuous, the fresh water maintains a healthy condition; and the same effect has been attained by a succession of bubbles of air introduced into and ascending through the water to maintain the natural equilibrium destroyed by the animals breathing therein. Agitation of the water produces the same results more or less perfectly, but the effect is not so pleasing unless it be introduced with scenic devices or machines, such as paddles, wheels, mills, or moving automatons which require a supply of water to make them constant.

In 1849 N. B. Ward grew sea-weed in artificial sea-water. A great aquarium, one hundred and fifty

Fig. 285.

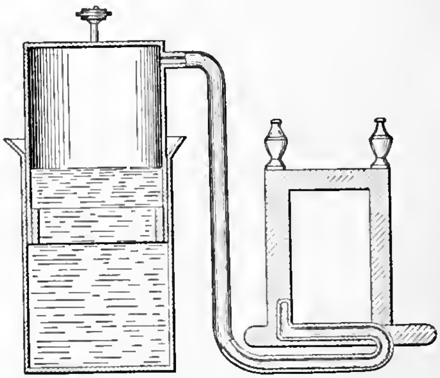


Aquarium.

feet long and thirty-six feet wide, was constructed in 1860 in the Jardin d'Acclimation in Paris by Alford Lloyd of London. The same gentleman erected a magnificent aquarium in Hamburg.

Fig. 286 shows an arrangement for the introduction of air for the revivification of the water. It is an air-forcing apparatus consisting of an inverted weighted vessel whose edges are submerged in the

Fig. 286.



Cutting's Aquarium.

water of the reservoir, and which connects by a flexible pipe with the interior of the tank. As the inverted weighted air-holder descends gradually, it forces air through the flexible pipe into the aquarium.

The aquarium of the Paris Exposition was a remarkable success, and has given rise to much more ambitious structures. The aquarium of Brighton, England, for instance, occupies ground 715 feet in length, with an average width of a hundred feet. The aquarium proper is divided into three corridors. The first is divided again into nineteen bays, which are roofed over with bricks, groined vaulting of red and black alternating with red and buff. The arches, ribs, and bosses are of Bath stone. The extreme length of the corridor is broken most effectively by a central square 55 by 45 feet, the groined vaulting forming a sort of cloister around the square, while the central portion is covered with an elaborate ornamental iron roof, partly glazed with antique colored glass. The tanks are arranged on either side, twenty-eight in number, averaging in size from 11 x 20 feet to 55 x 30 feet. The whole front work of the tanks is of Portland stone, ornamented with appropriate devices of fish, shells, marine monsters, and aquatic symbols. These fronts are inclosed by plate glass of great thickness, secured to the stonework by waterproof cement. The area of water surface visible in the rear of the glass is 9 feet wide by 5 feet deep. The light of the corridors is only transmitted through the water, thus affording to the visitor the sensation of being under water without the inconvenience of a wetting. At the eastern extremity of this corridor, which is 220 feet in length, the visitor finds before him the entrance to a fine conservatory. This entrance is at the junction of the first and second corridors; the latter, running north and south, forms right angles with the first corridor. The conservatory is 160 feet long by 40 feet wide and 30 feet high. The ornamentation of this apartment is in keeping with that of the other parts of the building. It is chiefly intended for a sort of subterranean promenade, and is ornamented with plants, ferns, small aquaria, etc. Corridor No. 3, which is approached from No. 2, is of the same length as the conservatory, contains twenty tanks, some for fresh-water, others for salt-water fishes. At the end of this corridor are the engines and the store tanks, boiler, retiring and naturalists' rooms, and another flight of steps leading to the terrace.

The water for the tanks is supplied, by means of pumps, from reservoirs beneath the floor of the building; and by an arrangement of pipes and pumping the water is kept constantly in motion throughout the aquarium.

The whole cost about $ 250,000.

A-quat'ic Box. An accessory to the microscope in the form of a shallow glass cell in which algæ or animalculæ are placed for observation.

A'qua-tint. A peculiar style of engraving on metal said to have been invented by St. Non, a French artist, about 1662. Otherwise stated to have been invented by Le Prince, Metz, 1723. The process, briefly described, is as follows: A surface of resin is spread upon a polished plate in such a manner as to leave innumerable little interstices between the resinous particles. This surface covering is called a *ground*, and may be made in two ways, — the dry process and the solution process.

The dry process is performed by dusting over the very slightly greased surface of the plate a shower of finely powdered resin. The surplus having been removed by tapping the plate, which is held in a reversed position, the particles are caused to adhere to the plate by warming the latter over a lamp, or, what is much better, the moderate diffused heat of a piece of burning paper. In the interstices between the particles of resin the plate is exposed to the action of acid, of which presently.

The solution process consists in dissolving the resin in alcohol and flooding the plate with it, allowing the liquid to run off; a film adheres to the plate and cracks in drying, leaving innumerable fine fissures where the plate is exposed.

The design is now placed on the "ground," or it may have been previously etched in; the latter is now preferred. A wall of wax being erected around the design, it is flooded with dilute acid, as explained under ETCHING (which see). For copper plate, dilute nitrous acid is used (acid, 1; water, 5). For steel, dilute nitric and pyroligneous acid is used (nitric acid, 1; pyroligneous acid, 1; water, 6). As soon as the lighter tints are sufficiently *bit in*, the acid is removed and the plate washed and dried. The light portions being *stopped out*, that is, covered with Brunswick black to protect them from farther action of the acid, the latter is again applied for the second tint, and so on. The delicate gradations are obtained by *flooding* and *feathering*, which are nice technical operations, requiring skill only attained by practice, and for a description of which we cannot spare room. This is a cheap and effective mode of engraving, and is not estimated at its proper value. The effect produced is like a drawing in india ink.

For different grounds the resin is more or less diluted; the greater the dilution the finer the ground, that is, the more delicate and numerous are the interstices in which the acid acts. A different ground is also obtained by a change of ingredients. Bergundy pitch, mastic, frankincense, and other resins, give various patterns of grounds, so to speak.

Aq'ue-duct. A conduit for the conveyance of water. More particularly applied to those of considerable magnitude intended to supply cities and towns with water derived from a distance for domestic purposes, or for conveying the water of canals across rivers or valleys. Pocock describes one erected by Solomon for conveying water from the vicinity of Bethlehem to Jerusalem. This was formed by earthen pipes about ten inches in diameter, encased with stone and sunk into the ground, and would seem to have conformed to its inequalities, indicating a more advanced state of hydraulic engineering in Solomon's time than is commonly supposed to have been possessed by the earlier Romans, who were justly famed for their works of this kind, which have never been surpassed in strength and beauty.

The earliest account of any aqueduct for conveying water is probably that which is given by Herodotus (who was born 484 B. C.). He describes the mode in which an ancient aqueduct was made by Eupalinus, an architect of Megara, to supply the city of Samos with water. In the course of the aqueduct a tunnel, nearly a mile in length, was pierced through a hill, and a channel three feet wide made to convey the water.

The first of the Roman aqueducts (Aqua Appia) was built, according to Diodorus, by Appius Claudius, in the year of the city 441, or 312 B. C. The water which it supplied was collected from the neighborhood of Frascati, eleven miles from Rome, and its summit was about one hundred feet above the level of the city.

The second (Anio Vetus) was begun forty years after the last-named, by M. Curius Dentatus, and finished by Fulvius Flaccus: it was supplied from the country beyond Tivoli, forty-three miles distant. Near Vicovaro it is cut through a rock upwards of a mile in length, in which part it is five feet high and four feet wide. The water of this aqueduct was not good, and therefore only used for the most ordinary purposes.

The third (Aqua Martia) was supplied from a fountain at the extremity of the mountains of the Peligni. The water entered the city by the Esquiline Gate. This aqueduct was the work of Quintus Martius, and had nearly seven thousand arches in a course of thirty-nine miles.

The fourth (Aqua Tepula) was supplied from the vicinity of Frascati.

The fifth (Aqua Julia) was about six miles long, and entered the city near the Porta Esquilina.

The sixth (Aqua Virginis) was constructed by Agrippa thirteen years after the Julia. Its summit, in the territory of Tusculum, was about eight miles from Rome, which it entered by the Pincian Gate. This water still bears its ancient appellation, being called Acqua Vergine.

The seventh (Aqua Alsietina, called also Augusta, from the use to which Augustus intended to apply it for supplying his Naumachia) was brought from the lake whose name it bears.

The eighth (Aqua Claudia), begun by Caligula and completed by Claudius, is about forty miles in length. It enters the city at the Porta Nevia, near the Esquiline Mount. The quality of the water which this aqueduct supplies is better than that of any of the others. It was built of hewn stone and supported on arcades during seven miles of its length. After a lapse of eighteen hundred years it still continues to furnish Modern Rome with pure and wholesome water.

The ninth (Anio Novus, to distinguish it from the second-named water) was begun and finished by the same persons as the last-mentioned. It is the water of the Anio, which, being exceedingly thick and muddy after the rains, is conveyed into a large reservoir at some little distance from Rome, to allow the mud to subside.

The Acqua Felice is modern, and was erected by Sixtus V. in 1581.

The Popes have, from time to time, been at considerable pains and expense in repairing and renewing the aqueducts; but the quantity of water delivered is constantly diminishing. In the ancient city the sum-total of the areas of the different pipes (which were about an inch in diameter) through which the above immense quantity of water was delivered, amounted to about 14,900 superficial inches; but the supply was subsequently reduced to 1170.

The waters were collected in reservoirs called *castella*, and thence were conveyed through the city in leaden pipes. The keepers of the reservoirs were called *castellani*. Agrippa alone built thirty of these reservoirs during his ædileship. There are five modern ones now standing in the city: one at the Porta Maggiore, Castello dell' Acqua Giulia, dell' Acqua Felice, dell' Acqua Paolina, and that called the Fountain of Trevi.

The aim of the Roman aqueduct-builders was to conduct the water along with an equal fall during the whole distance from its source to the point of delivery; and for this purpose, instead of allowing the conduits to follow the natural slope of the ground, they almost always erected long and massive stone arcades wherever it was necessary to cross a valley, instead of availing themselves of the well-known property of water to find its level. This was perhaps necessary in the then state of the mechanic arts, the art of casting iron pipes of large size being unknown.

It has been calculated that the nine earlier aqueducts of Rome had a total length of more than 249 miles, and the supply of water to Ancient Rome was computed by Professor Leslie, on the authority of Sextus Julius Frontinus, who was inspector of the aqueducts under the Emperor Nerva, and who has left a valuable treatise on the subject, at fifty million cubic feet per day for a population of one million souls. This gives the immense average per head of fifty cubic feet, or three hundred and twelve gallons, per diem, — a consumption quite unequalled in modern times, except in the city of New York, where it is said to have formerly amounted nearly to this quantity.

The aqueducts of Metz, Nismes, and Segovia are also striking examples of the attention paid by the Romans to the subject of supplying water to their towns and cities.

It does not appear that the ancients were by any means ignorant of the applicability of pipes for conducting water, and it is difficult to conceive how it could have been distributed to the baths and fountains of Rome without their aid. Their system appears to have been the result of calculation and design, and it is notable that in the greatest works of the kind of modern times, such as the aqueduct of Marseilles and the Croton Aqueduct, their leading principles have been carried out, and the use of pipes following the elevations and depressions of the hills and valleys has been in a great degree dispensed with, where the water had to be conveyed along a course of considerable length, — though, in general, without resorting to such an extensive, or indeed excessive, use of long and expensive arcades as the Romans employed.

The advantages of this system seem to be, more perfect freedom from deposition of mineral substances in solution in the channel way, owing to the more uniform and regular flow of water which can be obtained; facility of constructing traps or wells along the route for the deposition of sediment; greater security from interruption and opportunity for repair in case of accident.

The aqueduct of Nismes, or the Pont du Gard, in France, is one of the earliest constructed by the Romans out of Italy, and is supposed to have been built in the time of Augustus; it was intended for carrying the waters of the Eure and Airan from the vicinity of their sources to the town of Nismes.

The commencement of this aqueduct was conducted along the sinuosities of a hill, entirely under ground, and was often cut in the rock itself. Small bridges were thrown over the streams crossed in its course, and it passed over a series of arches, resembling those of the upper part of the great arcade of the Pont du Gard, followed the crest of a hill to avoid unnecessary hight in the piers, and after a course of about 9⅝ miles arrived at the Pont du Gard, by which it is carried over the river Gardon at a hight of more than 157 feet above the surface of the stream below.

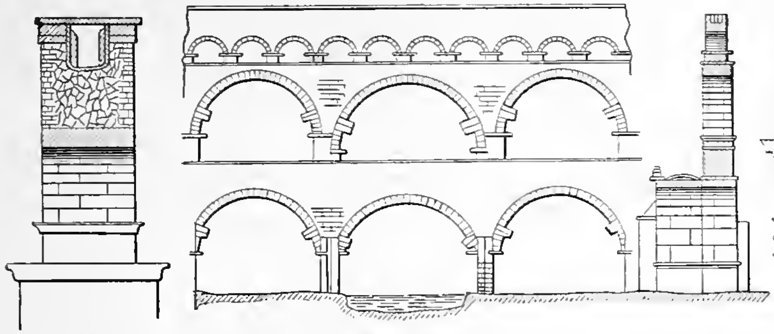
This magnificent structure consists of three tiers of arches, on the upper one of which the water-way is carried. The length at the level of the string course surmounting the lower tier of arches is 562 feet, and at the string course of the second tier 885 feet.

The large arch through which the river passes is 80 feet 5 inches in span, the three on the right side of this are 63 feet, and the smaller ones 51 feet. Those of the upper story are all equal, 15 feet 9 inches in span; their piers vary in width, and do not come immediately over those below.

The whole is constructed of freestone, from the foundation to the third course above the cymatium covering the piers of the upper story. Rubble was employed for filling in the piers, spandrels, and haunches of the first and second stories.

The stones were laid without cement, each being raised by the lewis, the holes for the insertion of

Fig. 287.



Section of Upper Story, enlarged scale. *Pont du Gard.* Side Elevation. Section.

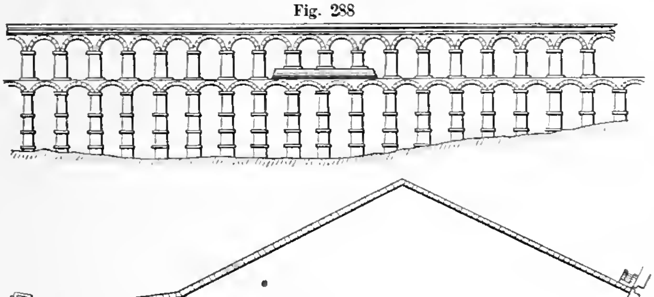
which are still to be seen exactly over the center of gravity of each stone.

The dimensions of the water-way are 4 feet in width and 4 feet 9 inches high ; the fall throughout its entire length is 2.112 inches per mile, and it is estimated to have been capable of supplying from 14 to 18 millions of gallons of water per day.

The entire length of the aqueduct is over 25½ miles.

The aqueduct of Segovia, Spain, was built by the Emperor Trajan, and is of squared stone laid without mortar, and in crossing a valley has a length

Fig. 288

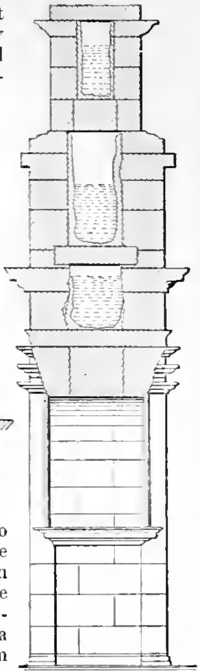


Aqueduct of Segovia.

of more than 2,200 feet ; it is in many places nearly 100 feet high. An elevation and plan are shown in Fig. 288.

The waters of the Aquæ Julia, Tepula, and Martia at Rome were conducted through a triple aqueduct, forming three channels, one above the other, as shown in the accompanying section ; the Aqua Martia being the lowest, the Aqua Tepula the middle, and the Aqua Julia the uppermost of the series. Particular care was taken to prevent leakage from one into the other, so that the water of better quality might not become deteriorated by mingling with that of inferior clearness and purity ; to effect this, the bottom of the channel of each was based upon thick stones passing into the sides of the aqueduct, and carefully lined with tiles and a coating of cement. Doors from the outside admitted the persons in charge to examine the condition of the conduits at any time, and they were required to report constantly upon their efficiency and state of repair.

Fig. 289.



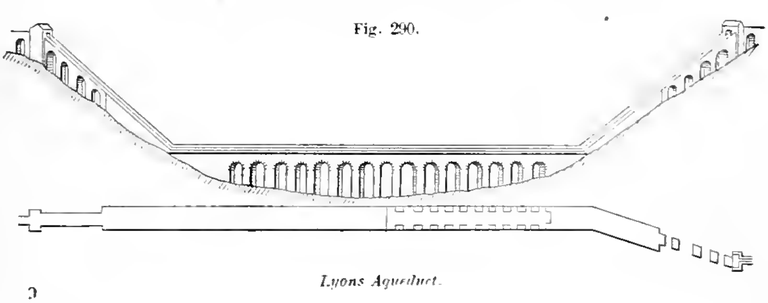
Roman Aqueducts, Julia, Tepula, and Martia.

The accompanying illustration (Fig. 290) shows one plan adopted by the Romans for conveying water across a valley. The aqueduct was erected by the Emperor Claudius for supplying a palace in an elevated part of the ancient city of Lugdunum (Lyons).

The channel-way, both in ascending and descending, was formed by masonry, tiles, and cement.

The work was performed as follows : A level pavement was formed of brick, on which was raised a frame or caisson of timber planks ; against the sides of this, squared stones were laid in regular courses, and their interior filled in with rubble in a dry state, after which a grouting of liquid cement was poured in to consolidate the whole. Lime, fine

Fig. 290.



Lyons Aqueduct.

gravel or sand, mixed with a due proportion of water, formed this grouting. After a sufficient time had allowed this work to consolidate, the caisson was mounted upon another course or layer of tiles, and similar operations to the first took place.

The bricks or tiles used were 21 inches in length, 12 inches in breadth, and $1\frac{1}{2}$ inches in thickness.

The whole of the water conduit was coated with cement; at bottom, its thickness was 6 inches, at the sides $1\frac{1}{2}$ inches. 24 inches from the bottom of the canal, at distances of 30 inches apart, the side walls were stayed with iron ties to prevent their being burst apart.

In the ancient aqueduct at Lyons, called at one part of its course Mont de Pile and at another Champonest, the water was brought over eight bridges in the usual manner, and a siphon was employed for conducting it across the ninth. At this point the valley is very deep, and a reservoir was built from which leaden pipes of large size, bedded in the sides of the valley, conducted the water to others laid over a bridge in an inverted curve; they were then conducted up the opposite side of the valley, and delivered the water into a reservoir at the same level as the first; from this they were conducted under ground for some distance, and thence, by a bridge of ninety arcades, to another reservoir, from whence it again descended into a valley through similar leaden pipes, crossing a river and ascending the other side of the valley, where it was delivered into a reservoir on that side. From thence it was carried, partially over arcades, to a reservoir at one of the gates of the city, from whence again it was carried by leaden pipes, first falling and again rising until it reached the reservoir from whence it was finally distributed; in this last instance the pipes were bedded in solid masonry, and not carried over a bridge.

The total length of this remarkable piece of work, which certainly seems to combine all the known appliances for conveying water without the aid of extraneous mechanical power, was 13 leagues, and the fall in this distance upward of 350 feet.

Wherever the aqueduct was tunneled in the sides of the hills at a considerable distance below the surface, wells were sunk to carry off any vapors which might accumulate, and to admit light and air; they also afforded access to any workmen who might be employed to make repairs or remove accumulated deposits in the channel: these were at distances of 120 feet apart. Perpendicular vent-pipes were also erected for ventilating purposes. The walls, where the work was above ground, were two feet thick, and the arches were roofed over to shed rain. The entrance to the aqueduct was through iron doors opening internally. The underground portions were accessible by traps or man-holes brought up a little above the level of the soil.

Pipes, in cases where a very large supply of water is not required, undoubtedly possess many advantages, and in very broken and rugged localities their use, either alone, or in combination with masonry or brick conduits, along the more level portions of the route, is indispensable without increasing the cost of the work beyond all reasonable bounds; but it would seem, both from the experience of antiquity and that of more recent times, that the stone or brick channel into which the air is freely admitted, and to which ready access can be had for the removal of impurities or obstructions, is, when the engineering difficulties and cost are not too great, preferable to any other.

This of course does not apply to the delivery and discharge of water within cities or towns; there, metallic pipes of some kind are indispensable. Cast-iron is the material now universally employed for the larger pipes of this description, called *mains*, and is perfectly unobjectionable in every respect. Leaden pipe is very extensively employed in buildings for discharging water, but, unless kept constantly filled, is a very dangerous material, its salts being active poisons. Lining with tin is a good expedient.

In China and Japan, bamboos of large size are used to convey water from one point to another.

The ancient works executed under the later Roman emperors for the supply of Constantinople combine the system of aqueducts with the collection and impounding of water by means of reservoirs at the head of the aqueduct. The impounding reservoirs are situate about twelve miles from the city, on the slopes of a range of mountains which form the southeastern prolongation of the great Balkan chain. There are four principal aqueducts, one of which conveys the water collected by three separate reservoirs, while the other three are each supplied by its own reservoir. Besides these extensive provisions for securing water to the city, there are immense subterranean reservoirs, one of which, now in ruins, is called the Palace of the Thousand and One Pillars, not because this is the precise number supporting the roof, but because the number is a favorite one in the expression of Eastern hyperbole. This great subterranean cistern is supposed to have been made by the Greek emperors for the purpose of storing water in case of a siege or similar calamity. Although originally of great depth, it is now nearly filled up with earth and rubbish. It is singular that in the nineteenth century we are reviving in our covered reservoirs, for the purpose of storing water in a state of freshness and uniform temperature, the practices which were followed nearly two thousand years ago by nations whose modern descendants are half barbarians.

Works of great magnitude were, according to Garcilasso, constructed for purposes of irrigation by the ancient Peruvians, previous to the conquest of that country by the Spaniards.

On the western slopes of the Andes there are immense districts where rain never falls, and which are incapable of cultivation unless watered by artificial means. The Incas caused numerous aqueducts to be constructed for this purpose: one of these is stated to have been 120 leagues in length and 12 feet in depth, and to have watered a tract of country more than 50 miles in width; another was 150 leagues in length, traversing an extensive province and irrigating a vast and arid district of pasture land.

The Peruvians do not appear to have advanced so far as the use of bridges or pipes for conducting the water across valleys, — their purpose probably did not require it, — but gave their aqueducts a sinuous course, winding around the mountains and through the valleys with sufficient inclination to allow the water to flow freely.

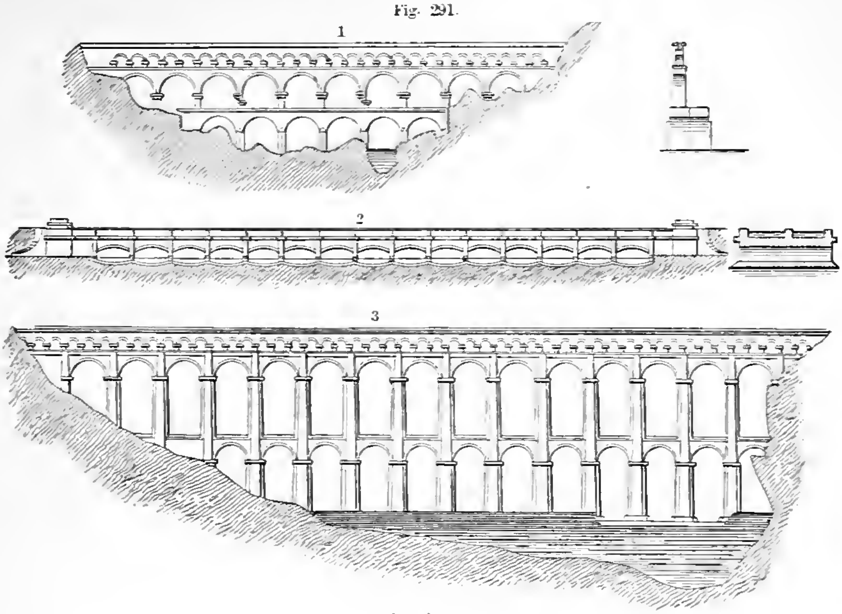
The French aqueducts referred to in this article are most of them of great magnitude and importance, and the most stupendous work of the kind ever projected originated in France. This was the aqueduct of Maintenon, which was undertaken in 1684 and abandoned in 1688, during which time 22,000,000 francs are said to have been expended upon it. It was intended to have brought water from the river Eure at Pongoin to Versailles, a distance of nearly 25 leagues, and embraced an arcade of masonry 16,090 feet in length, comprising three tiers of arches at its highest part.

The illustrations (Fig. 291) exhibit to the same scale, —

1. The *Pont du Gard Aqueduct*, at Nismes, under which the river Gardon passes, and which was built by the Romans, possibly by Agrippa. The conduit is 157 feet above the river, and is referred to above.

2. The *Solani Aqueduct* of the Ganges Canal; the area of the water-way is eighty times that of the Pont du Gard.

Fig. 291.



Aqueducts.

3. The *Roquefavour Aqueduct*, erected by Montricher to conduct the waters of the Durance to Marseilles.

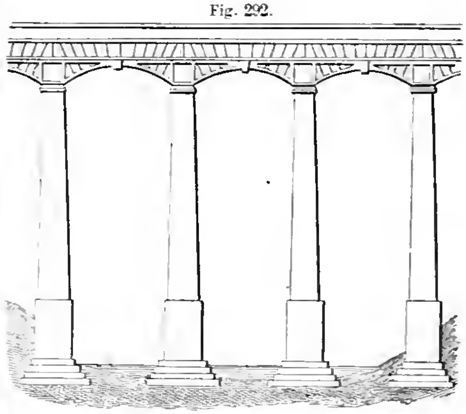
The aqueduct for supplying Marseilles with water extends from the river Durance, a distance of 51 miles, though a very hilly country. It comprises 78 tunnels, having a united length of over 12 miles. It has 500 bridges, embankments, and other artificial constructions. Marseilles lies in a large arid basin, and the aqueduct approaches the edge of the basin at a hight of 500 feet above the level of the sea. Branches extend to and irrigate the area of 25,000 acres, and also supply the city of Marseilles. The bridge over the valley of the Arc is 1,287 feet in length and 262 feet in hight. It is formed of a triple tier of arches; is said to have occupied from 700 to 800 workmen for seven years, and to have cost $750,000. The water channel is 30 feet wide at top, 10 at bottom, and is 7 feet deep. It delivers 11 tons of water per second.

The aqueduct of Chirk on the Ellesmere and Chester Canal in England is noted as being the first in which iron was employed, the bottom of the water channel being of cast-iron and the walls of masonry; that of Pont-y-Cysyilte, on the same canal, has the entire channel made of cast-iron arches or ribs resting on pillars of stone.

It carries the waters of the canal across the valley of the Dee. It is upwards of one thousand feet in length, consisting of nineteen arches of equal span, but varying in their hight above the ground. The three shown in elevation in Fig. 292 are the highest, being those which cross the river Dee itself; the surface of the canal is one hundred and twenty-seven feet above the usual level of the water in the river. The aqueduct itself is a cast-iron trough formed of plates with flanges securely bolted together. This trough is supported upon cast-iron arches, each composed of four ribs, supported upon piers of masonry. The towing-path overhangs the water, being supported at intervals on timber pillars.

Watt's submerged aqueduct across the bed of the Clyde was an articulated pipe whose joints rendered it flexible, so as to accommodate itself to the shape of the river-bed. It is stated to have been a success.

Fig. 292.



Pont-y-Cysyllte Aqueduct.

The Croton Aqueduct was commenced in 1837 and completed in 1842, costing $8,575,000.

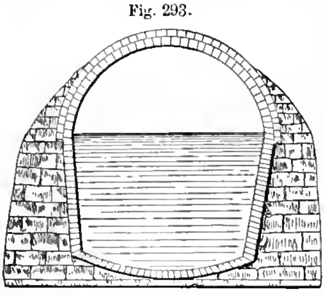
Its length is 40½ miles, 33 miles of which distance it is built of stone, brick, and cement, arched above and below. It has a capacity for discharging 60,000,000 of gallons per day. It is carried over the Harlem River by pipes laid upon a bridge consisting of fifteen arches, eight of 80 feet and seven of 50 feet span, rising to 114 feet above low-water mark.

At the spot where the Croton dam is constructed, the surface-water of the creek was about 38 feet lower than the elevation required as a head for the delivery of the water into the city of New York at a sufficient hight. By going farther up stream a dam of less hight would have been sufficient, but the supply of water would of course have been smaller. The medium flow of water at the dam is about 50,000,000 gallons daily, and the minimum in very dry seasons about 27,000,000 gallons.

The water is set back upon the course of the creek by the dam, about six miles, forming the reservoir, which has an area of about 400 acres, now called Croton Lake. The available capacity of this reservoir down to the point where the water would cease to flow into the aqueduct is estimated at 600,000,000 gallons, in addition to which the receiving reservoir in the city is capable of containing 150,000,000 more when full, which together afford a reserve supply of 750,000,000 gallons in seasons of extreme drought. In case of necessity other streams might be turned into the Croton River at or above the reservoir, or into the aqueduct.

From the dam at the lower end of Croton Lake to the receiving reservoir there is no essential change made in the form of the channel-way, except that, in crossing the Harlem River and a valley on Manhattan Island, iron pipes are used instead of masonry; at these places the pipes fall and rise again so that they are always full. The channel-way of masonry is never entirely filled, so as to cause a pressure on its interior surface. To avoid this, six waste weirs were constructed at suitable places to allow the water to flow off upon attaining a certain level.

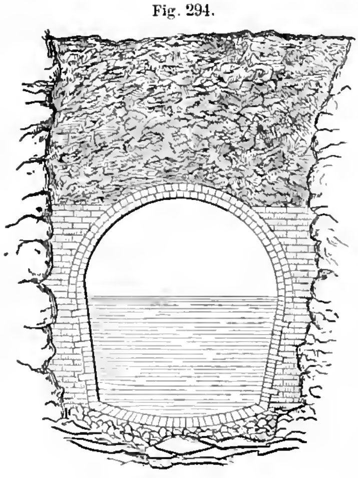
Fig. 293.



Earth Excavation.

Fig. 293 is a section showing the kind of masonry used in earth excavations. The foundation is of concrete, the side walls of stone, the bottom and sides of the interior faced with brick, and the top covered with an arch of brick.

Fig. 294.



Rock Excavation.

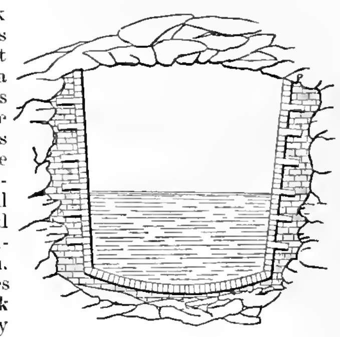
After the masonry was finished the excavation was filled up around it and over the top of the covering arch, generally to the depth of three or four feet, and in deep excavations up to the natural surface.

Fig. 294 shows a section in open cuttings in rock. The rock was excavated to the requisite depth and width, and the bottom filled in with concrete to the proper hight and form for receiving an inverted arch of brick; the side walls were of brick bonded with an outer casing of stone, built up closely against the sides of the rock. On the exterior of the roofing arch, and filling the space between it and the rock, spandrels of stone were built.

When finished, the space above the masonry was filled in with earth.

Fig. 295 is a section in tunnel cuttings in solid rock. In hard, sound rock the natural rock often served as a roof, but when soft, a brick arch was built over the channel walls and the space between its upper surface and the rock filled in with well-rammed earth. In some cases where the rock was originally hard, it was found to become soft and insecure upon exposure to the air, rendering it necessary to arch over the channel-way to support the natural roof.

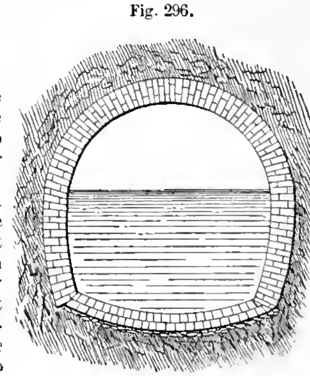
Fig. 295.



Rock Tunnel.

Fig. 296 is a section in earth tunnel cuttings. In dry and compact earth the excavation for the bottom and sides was made of just sufficient size to receive the masonry built closely against it; the top was made high enough to give room for turning the roofing arch, and when complete the space above it was filled with earth closely rammed. In wet earth the excavation was made larger and the top and sides supported by props of timber and plank until the masonry was completed; the vacant space around it was then compactly filled with earth. In crossing valleys, the aqueduct was supported on a foundation wall of stone, laid dry, and sloping embankments of earth were thrown up on each side of it.

Fig. 296.



Earth Tunnel.

At intervals of a mile apart, ventilating shafts of stone were erected over the aqueduct, rising about 14 feet above the surface of the ground; every third shaft was provided with a door to afford entrance to the interior of the aqueduct for the purpose of inspection or repairs. Openings two feet square were also made in the top of the roofing arch every quarter of a mile; each of these was covered by a flag-stone, and its position indicated by a small monument projecting above the surface; these are for the purpose of obtaining entrance or increasing the ventilation if necessary. Where the line of the work was intersected by streams, culverts were built to allow the water to pass under without injury to the aqueduct.

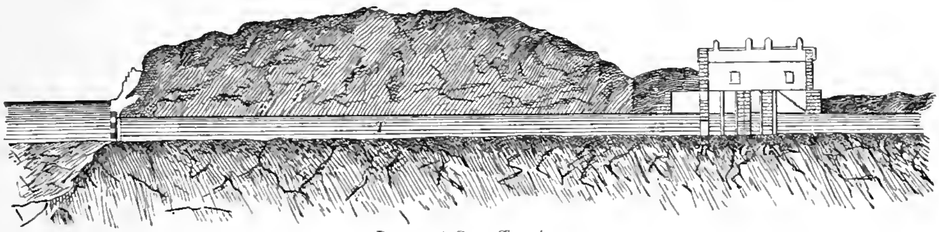
In connection with the reservoir at the dam is a tunnel and gate-chamber. The gate-chamber is not directly connected to the dam itself, but is at a distance of upwards of 200 feet. The water is conducted from the reservoir to the gate-chamber by means of the tunnel T, which is cut through the solid rock of the hill, having its entrance above the dam, its center being about 12 feet below the surface of the water, so that the entrance of floating bodies is prevented. In winter, when the reservoir is frozen over, there is no obstruction to the flow of water into the aqueduct, and in summer the water is drawn from a level where it is cooler and purer than at the surface.

The gate-chamber has two sets of gates, the one being called regulating gates, R, and the other guard-gates, G, G. The regulating gates are made of gun-metal, and work in frames of the same material, fitted to stone jambs and lintels; the guard-gates are of cast-iron, working in cast-iron frames, also attached to stone jambs and lintels.

The gates are managed by means of wrought-iron rods, having a screw on their upper part working in a brass nut set in a cast-iron socket-cap.

The accompanying view (Fig. 297) exhibits a section of the hill through which the tunnel is cut, showing its entrance into the reservoir, the gate-house and gates, and the point of discharge into the channel-way of the aqueduct.

Fig. 297.



Dam and Gate-Chamber

In the center of the dam and on its ridge is a gate-house over a culvert passing through the dam. This culvert is 30 feet below the surface of the water when the reservoir is full, and has gates opened by rods rising up into the gate-house. When the river is low, the water which is not carried off by the aqueduct may be allowed to pass through this culvert, preventing any from passing over the dam.

The bottom of the water-way of the aqueduct at the gate-chamber is 11.4 feet below the surface of the reservoir, and 154.77 feet above the level of mean tide at New York City.

The aqueduct is divided into different planes of descent from the gate-chamber at the dam to that of the receiving reservoir on Manhattan Island, and is as follows: —

	Length.		Descent.
	Feet.	Miles.	Feet.
First plane of aqueduct	26,099 72	4.943	2.94
Second plane of aqueduct	148,121.25	28.053	30 69
Length of pipes across the Harlem River	1,377.33	0.261	
Difference of level between the ends of the pipes			2.29
Third plane of aqueduct	10,733 14	2.033	2.25
Length of pipes across the Manhattan Valley	4,105 09	0.777	
Difference of level between the ends of the pipes			3.86
Fourth plane of aqueduct	10,680.89	2.023	1.60
	201,117.42	38.090	43.63

The hight of the interior of the aqueduct is 8 feet 5½ inches, and the greatest width 7 feet 5 inches: the interior having a sectional area of 53.34 square feet. On the first plane the aqueduct is larger, being 2.05 feet higher at the gate-chamber, 2.31 feet higher at 2,244 feet from the chamber, and diminishing to the head of the second plane, where it is of the dimensions above stated.

The curves used in changing the course of the aqueduct are generally of 500 feet radius; in some cases a radius of 1,000 feet or even more was employed.

The receiving reservoir is located between Sixth and Seventh Avenues and Seventy-ninth and Eighty-sixth Streets in the upper part of the city of New York. It is 1,826 feet long and 836 feet wide at the top of the external walls of the embankment, having a total area of 37 acres, the area of the water-surface being 31 acres. The reservoir is divided into two divisions by means of an embankment, either of which may be used independently while the water is drawn off from the other, in case of repairs, etc.

The greatest depth of water in the north division is 20 feet, in the south, 30 feet, and the total capacity of the whole 150,000,000 gallons. The aqueduct enters a gate-chamber in the south division, where there are regulating gates for discharging the water into either division by a continuation of the aqueduct within the reservoir. The two divisions are connected by a cast-iron pipe for equalizing the level of water in each. There is also a waste weir for the escape of surplus water into a sewer.

The embankment is of earth, protected on the outside by a stone wall four feet thick, the face of which is laid in mortar: the inside slope has a stone facing, 15 inches thick, laid without mortar.

From the receiving reservoir the water is carried by iron pipes to the distributing reservoir, a distance of 2.17 miles, with a fall of four feet. The distributing reservoir is 436 feet square at the base and 425 feet square at the corners, having an area of rather more than four acres, and a capacity of 20,000,000 gallons.

The outside walls have openings, so that by entering a door one may walk entirely round the reservoir within the walls, giving a greater breadth with a given amount of material, and affording an opportunity of examining the work for the purpose of obviating leakage, and also preventing water from finding its way to the exterior and causing injury to the wall by freezing. This open space rises to within about eight feet of the water-line. Inside of the wall is an embankment of puddled earth faced with hydraulic masonry 15 inches thick.

From the distributing reservoir the water is distributed over the city by means of cast-iron pipes of from 36 to 4 inches diameter.

The total cost of the work was $8,575,000, including the purchase of land, etc., being within five per cent of the engineer's estimate. In this the cost of the distributing pipes within the city is not included.

The Washington Aqueduct was built at the expense of the United States government, for the purpose of supplying the cities of Washington and Georgetown with water, and is distinguished by some bold features of engineering. The most remarkable of these is the bridge over Cabin John Creek, near the upper termination of the work, the widest spanned stone arch at the time of its construction; it has a span of 220 feet and a rise of 57 feet 3 inches.

The bridge over Rock Creek is also a peculiar and noteworthy application of the results of modern science and mechanical skill. The water is carried across this stream (which divides the cities of Washington and Georgetown) by means of two arches of cast-iron pipes of 3 feet 6 inches interior diameter, formed of sections with flanges firmly screwed to each other and braced; upon these are laid a bridge over which the street cars pass, and which serves as a public avenue of communication between the two cities. The span is 200 feet, and the rise 20 feet.

The aqueduct which supplies Madrid with water, and has a large surplus for irrigation, is fed from the river Lozoya, where it emerges from the Guardarama Mountains. This work was constructed under the superintendence of Don Lucio del Vallé, between 1851 and 1858, and is 47 miles in length. The river gorge is crossed by a cut-stone dam, 98 feet in hight, its wings abutting upon the solid rock of the hillsides. The artificial lake thus formed contains 100,000,000 cubic feet of water. The cost of the whole work was 57,897,368 francs.

The "canal," as it is termed, has seven miles of subterranean galleries, 4,600 feet of aqueducts, and 8,600 feet of inverted siphons at the crossings of three valleys. The siphon of Bedonal is 4,600 feet in length. The transverse section of the waterway has an area of about 20 square feet, and it discharges 6,600,000 cubic feet of water per day; one fifth is required for town service, the remainder being used in irrigating a tract of nearly 5,000 acres.

The town service has 45 miles of brick culverts about six feet high, and 60 miles of cast-iron pipes. It supplies 35 public fountains, and has 3,000 plugs for fire and irrigating purposes.

A novel expedient for the support of an aqueduct across a densely wooded ravine was suggested by Mr. M'Taggart, the resident engineer for the Rideau Canal in Canada. In a part of the country traversed by the canal, materials for forming an embankment, or stone for building the piers of an aqueduct, could not be obtained but at a great expense. The plan consisted of cutting across the large trees in the line of the works, at the level of the bottom of the canal, so as to render them fit for supporting a platform on their trunks, and on this platform the trough containing the water of the canal was intended to rest.

Ar′a-besque [ar′a-besk]. 1. (*Architecture.*) A species of ornament, either painted, inlaid, or carved in low relief, employed for decorating flat surfaces. It usually consists of convoluted and intertwined curves, intended to represent foliage, tendrils, and openwork checker patterns.

In a degraded form, various figures of animals, real or imaginary, have been introduced in the attempt to make it more consonant with the later taste for florid ornament. The Koran forbids the representation of the human form, but some have even deviated so far from the original designs of the Arabs as to blend satyrs, sirens, and mermaids in the design. This is on a par with the taste which degrades consoles into caryatides and pillars into atlantes.

2. (*Bookbinding.*) The English term for the impressed ornamental work on the sides of cloth and leather-bound books.

It is produced by the pressure of hot plates or rollers having the pattern engraved on them.

Ar-bac′cio. (*Fabric.*) A coarse woolen cloth made in Sardinia from the wool of an inferior breed of sheep, called the *Nuoro.*

Ar′bal-est. A kind of cross-bow used formerly by the Italians, and introduced into England in the thirteenth century. The arrows shot from it were termed *quarrels.*

Ar′bor. (*Machinery.*) *a.* An axle or spindle of a wheel or pinion. The term is specially used in horology.

b. A mandrel on which a ring, wheel, or collar is turned in a lathe.

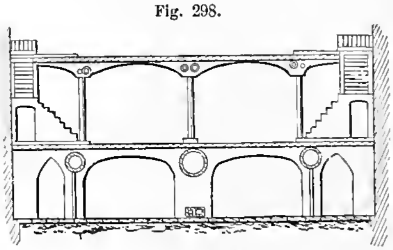
Ar-cade′. A vaulted avenue. A covered passage.

A number of streets in London and Paris are thus vaulted over, and are well known to many of our citizens; the Lowther and Burlington Arcades of the former city, for instance.

As one mode of connecting down-town and uptown of New York City, the arcade system has been proposed. Even of this, many forms have been suggested. One is to form a sub-way, a main-way, and an elevated railway.

Ar-cade′ Rail′way. The upper roadway to be supported by iron columns, and having gas and water tubes; the main-way by masonry, through which the sewers and pneumatic dispatch pass. Access to be had to the various levels by ramps and staircases.

Fig. 298.



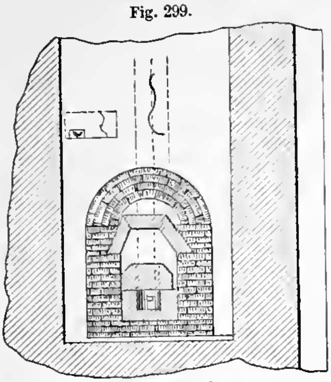
Arcade Railway.

Arc′bou-tant. An arched buttress forming a lateral support for the foot or haunch of another arch.

Arch. The antiquity of the arch, says Wilkinson, is traced to the time of Amunoph I., who reigned 1540 B. C. He also thinks it probable that the chambers of the brick Pyramids at Memphis, erected by the successor of the son of Cheops, would prove to be vaulted over with arches, which would carry back the antiquity of the arch to 2020 B. C.

In one of the Egyptian pyramids is an arch turned over three stones which formed a stone arched ceiling to the sarcophagus chamber. The two outer stones were set edgeways and inclined inward, having the other placed upon them, forming an arch.

Fig. 299.



Egyptian Arch.

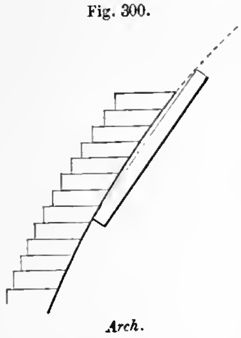
Over these stones was turned a brick arch, the radius of which was 6 feet 2 inches, and the span 11 feet. It consists of four courses, and is 3 feet 10 inches thick. The stones beneath were 4 feet long, and 15 inches in breadth. At the back the joints were packed with chips, and the whole was grouted with fluid mortar.

This tomb is of the time of Amunoph I., 1540 B. C. The stone arch at Saccara is of the time of Psammeticus II., 600 B. C. The arches of the tombs of Beni Hassan are coëval with Osirtasen II. and the Viceroy Joseph.

Arches are found in Chinese bridges of great antiquity and magnitude ; and as before shown, those of Egypt far antedate the periods of Greece or Rome. Arched vaults are found among the ruins of Nineveh.

A building at Mycenæ, in Greece, called "Treasury of Atreus," has an interior pointed dome of 48 feet diameter, and of about the same hight, the section presenting two intersecting arcs of about 70 feet radius. The difficulty of working voussoirs has been evaded by making the beds horizontal throughout, the top being formed of a flat stone. The soffit of each course was then cut to the required angle with its bed by means of a templet cut to the radius of the vault (Fig. 300).

Fig. 300.



Arch.

This form of arch is sometimes known as the "Egyptian," and of course is an arch merely in name, the constructive principle being entirely different, as the stones of which it is c mposed are only subject to vertical pressure.

The Greeks did not allow arches to appear in their visible architecture, but used them for covering drains and the like, as in the temple of the Sun at Athens and that of Apollo at Didymos. It was, however, contrary to their architectural principles to admit any but straight lines into any visible part of a building, except, perhaps, as mere ornamentation, thus sacrificing in many instances convenience to secure that severe simplicity of outline by which their public structures were characterized. The Romans made very free use of them. The Cloaca Maxima, or Great Sewer, of Rome, is the oldest known example of Roman workmanship ; it is believed to have been constructed more than five hundred years before the Christian era, and is yet in a perfect state of preservation, still continuing to perform its original functions. That people also used arches as triumphal monuments ; the arch of Titus was erected A. D. 80 ; that of Trajan, A. D. 114 ; and of Constantine, A. D. 312. The Gothic style, which originated about the ninth century, and soon spread over the whole of Europe, was emphatically the style of arches. Its special characteristics are the clustered pillar and the pointed arch. The mediæval masons treated them with a boldness and freedom unknown to the builders of Ancient Rome.

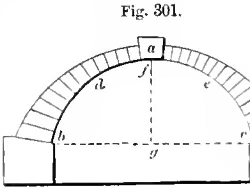
Their constructions display an astonishing amount of practical science, and clearly show that their taste was equal to their skill. Long before the properties of the catenary had been developed by Hooke, it is more than probable that they were known in practice to the old Freemasons who built Henry VII.'s chapel and other structures of similar and previous date. The span and hight of some of the principal vaulted arched structures are as follows : —

Date.		Breadth.	Hight.	Proportion.
		Feet.	Feet.	
Tarquin I.	The Cloaca Maxima	16	26	1 : 1 625
1st century	" Temple of Peace	83	121	1 : 1.46
13th "	Cathedral of Salisbury	35	84	1 : 2.3
" "	" of Amiens	42	147	1 : 3.5
" "	Westminster Abbey	33	99	1 : 3
14th "	Milan Cathedral	55	165	1 : 3.
17th "	St. Peter's, Rome	84	147	1 : 1.75
" "	St. Paul's, London	41	82	1 : 2.

For examples of arches used in bridge construction, see BRIDGE.

The term "arch" in its widest signification, is commonly understood to mean almost anything of a curved shape employed for the purpose of bearing weight or resisting pressure, but in its more restricted mechanical sense may be defined as a collection of wedge-shaped bodies termed *voussoirs* or arch-stones, of which the first and last at each extremity are sustained by a support or abutment, while the intermediate ones are held in position by their mutual pressure and the adhesion of the mortar or cement interposed between them. The center voussoir *a*, in the highest part, or *crown*, of the arch, is called the *keystone*. The inferior surface of the arch, *b d f e c*, is the *intrados*, or *soffit*, but this latter term is sometimes restricted to that part of the under surface in the immediate vicinity of the keystone, or crown.

Fig. 301.

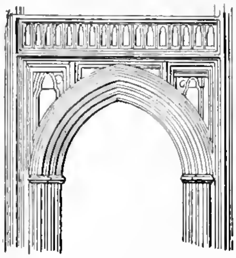


Arch.

b d, *e c*, are the *flanks* of the arch. The exterior or top surface is called the *extrados*, or back. The points, *b c*, where the intrados meets the abutments, are called the *springings*; their horizontal distance apart, the *span* ; and the distance, *g f*, from the center of this to the center of the intrados, the *rise* or height of the arch.

The simplest, as it is the earliest, form of arch, is that of a segment of a circle, generally less than a semicircumference, such as is found in the works of the Romans. The Gothic architects about the tenth century originated the pointed arch, formed by two arcs of circles described from different centers, and meeting at the crown. Three and four centered arches were introduced into the later Gothic architecture.

302.

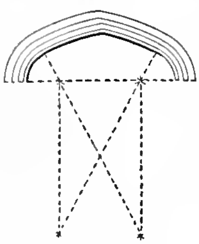


Three-Centered Arch.

In the three-centered arch the lower part to the bends of the haunches was formed by the corresponding opposite arcs of one circle having its center in a line perpendicularly beneath the crown of the arch, the upper opposite sides to the crown being described with equal radii, greater than the radius of the lower part, from centers at equal distances on each side of the perpendicular passing through the crown of the arch.

The four-centered arch was, as its name imports, described from four centers, the two lower centers being perpendicularly under the two upper ones; from the latter are described the lower parts of the arch near the risings, and from the former, with greater radii, the upper parts to the crown; of this form is the Tudor arch, bearing somewhat of a resemblance to the ellipse. The elliptic arch is employed largely in bridge building and in the construction of vaults, drains, etc.

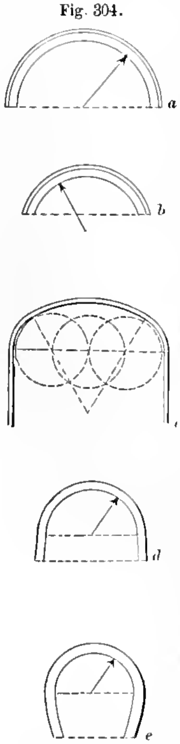
Fig. 303.



Four-Centered Arch.

In Fig. 304 are shown some of the forms of arches employed in architecture.

Fig. 304.



Forms of Arches.

a. The *Semicircular* arch, describing half a circle.

b. The *Segment* arch, struck from a point below the springings.

c. The *Elliptic* arch is not always truly elliptical, but is sometimes formed by the combination of the arcs of several circles.

d. The *Stilted* arch rises from points below its center.

e. The *Horseshoe* arch is peculiar to the Moorish or Arabic style of architecture.

Various styles of pointed arches were employed by the Gothic architects, as shown in Fig. 305.

a. The *Equilateral* arch; so termed because the two springing points and the crown of the intrados form an equilateral triangle.

b. The *Lancet* arch is more pointed than the equilateral arch; and

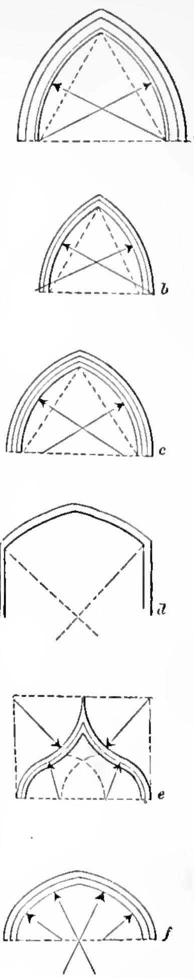
c. The *Drop* arch less so.

d. The *Segmental Gothic* arch is composed of two segments of circles meeting obtusely.

e. The *Ogee* arch was introduced at a later period of Gothic architecture.

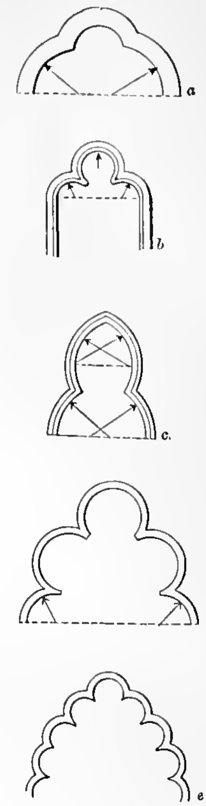
f. The *Tudor* style prevailed during the close of this most graceful order, and was so named from the then ruling family of the English dynasty. It has a much flattened arch, low moldings, and a profusion of panelings.

Fig. 305.



Gothic Arches.

Fig. 306.



Foiled Arches.

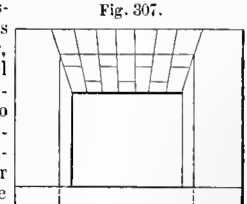
Foiled arches, Fig. 306, are so called from the compartments, imitating the *foils* of a leaf, into which they are divided: as, —

a, b, c. *Trefoils.*
d. *Cinquefoil.*
e. *Polyfoil.*

The latter is principally met with in Saracenic and Romanesque buildings.

The *Flat* arch (Fig. 307) is very generally employed in doorways, fireplaces, and windows of buildings; its intrados has no curve, though the voussoirs are arranged so as to radiate to a center, and are laid in parallel courses; where any considerable pressure is to be resisted, it is usually supported by horizontal bars of iron or wood laid across the opening and having their ends supported in the wall on each side.

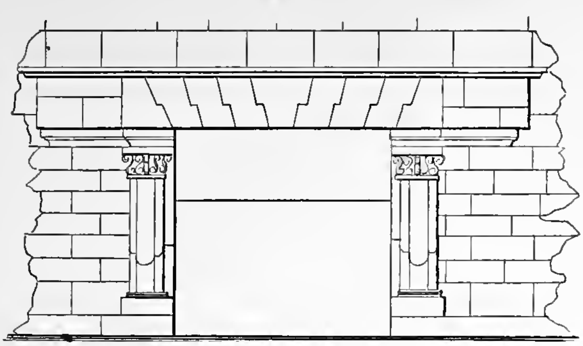
Fig. 307.



Flat Arch.

In some examples of old date the voussoirs are held up by indented joints which fit into each other. In this form of arch it is manifest that almost the

Fig. 308.



Fireplace of Coningsburgh Castle.

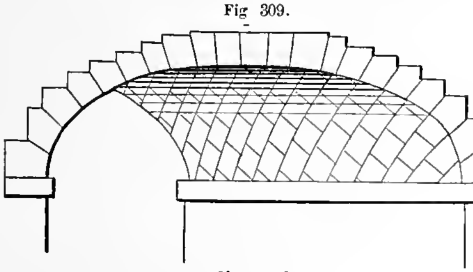
whole pressure is vertical, and that the arch is supported principally by the cohesion of the parts; so that it cannot be used for covering any but narrow openings. As at present employed in brickwork, its principal use is to relieve the pressure on a beam or lintel below it.

Oblique, generally called skew, arches have their axes oblique to their faces, and on account of the difficulty of their construction are seldom employed, unless in railroad bridges where the direction of the line of the road renders it necessary to cross streams obliquely to their courses. In such cases it is necessary that the piers should be parallel to the current of the stream, in order to offer as little resistance as possible and afford a free passage to tho water.

A bridge arched in this manner is said to have been built near Florence as early as 1530, but their general introduction dates no farther back than the era of the commencement of railroad construction, about or a little previous to 1830.

The ordinary method of building a skew arch (Fig. 390) is to make it a portion of a hollow cylinder, the voussoirs being laid in parallel spiral courses, and their beds worked in such a manner that in any section of the cylinder perpendicular to its axis the lines formed by their intersection with the plane of section shall radiate from the axis of the cylinder. In this mode of construction the soffit of each stone will be a portion of a cylindrical surface, and the twist of the beds will be uniform throughout the whole of the arch; so that we have only to settle the amount of the twist, and the stones can then be worked with almost as great facility as the voussoirs of an ordinary arch. The *heading* joints, or those which divide the stones of each course, are portions of spirals intersecting at right angles the *coursing* joints, or those which divide the stones of each course, so that the voussoirs are rectangular on the soffit, except those quoins or voussoirs on the faces of the arch where the section exhibited is elliptical.

Fig 309.



Skew Arch.

In Fig. 310, instead of radiating the bed-joints from the center of the cylinder, they are made perpendicular to the curve of the soffit on the oblique section.

Of the parts of an arch, —

The top is the *extrados*, or *back*.

The under-side the *intrados*, or *soffit*.

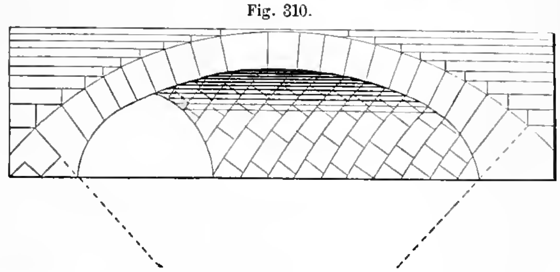
The line from which it commences is the *springing line*.

The stones of the arch are *voussoirs*.

The lower one on each side is a *springer*, or *rein*.

The middle one is the *keystone*, and the course the *key-course*.

Fig. 310.



Skew Arch.

The upper portion is the *vertex*, or *crown*.

Midway between the *crown* and the *springings* are the *haunches*, or *flanks*.

The *springers*, or *reins*, rest on *imposts, abutments*, or *piers*.

The extreme width is the *span*.

The rise of the curve in the center is the *versed sine*, or *rise*.

The space between the *haunch* and the outscribing rectangle is the *spandrel*.

The joints between *voussoirs* are the *abreuvoirs;* which are perpendicular to the surface of the *soffit*.

The exposed vertical surface is the *face*.

An *Annealing Arch* is the oven in which glass is allowed to cool gradually. See ANNEALING.

An *Arabian Arch* is one of horseshoe shape. The diameter is less at the springings than above.

A *Basket-handle Arch* is a three-centered, low-crowned arch.

A *Blind Arch* is a closed arch; one which does not penetrate the structure. Commonly employed for mere ornamentation, to make one face of a building correspond in character with another front where there are actually arched openings.

A *Catenarian Arch* is one in the form of an inverted catenary curve, or that which a chain suspended at each end naturally assumes.

A *Compound Arch* has an archivolt receding in steps; giving the appearance of a succession of receding arches, of varying spans and versed sines.

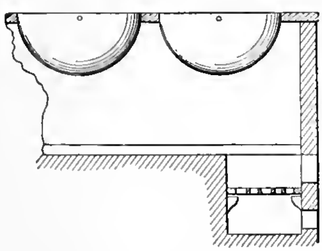
A *Concentric Arch* is one of several courses whose curves have a common center. Common in Norman and Saxon architecture.

A *Discharging Arch* is one which is formed in a wall to protect a space beneath from the superincumbent weight.

An *Arch of Equilibrium* is one in which all parts are of similar strength, and the whole capable of standing without abutments.

An *Arch of Equipollence* is one in which the voussoirs are sustained by mutual opposition; the thrust of the crown being transferred from one stone to another till it reaches the abutments.

Fig. 311.



Furnace Arch.

A *Furnace Arch* is one which spans the fire-chamber and supports a battery of kettles; or it may form the ceiling and roof of a metallurgic furnace, — a *puddling* furnace, for instance.

A *Groined Arch* is one intersected by other arches cutting across it transversely. The point of junction is a *groin*.

An *Inflected Arch* is a reversed or inverted arch.

An *Inverted Arch* is one with the crown downwards, as in the floor of a tunnel, the space beneath an opening in a foundation-wall, etc.

A *Lancet Arch* is a narrow peaked arch, which was much employed for windows during the prevalence of the Gothic style of architecture, known as Early English.

A *Laminated Arch* is one made of successive thicknesses of planking, bent into shape, and secured together by treenails or otherwise. See ARCHED BEAM; LAMINATED ARCH.

A *Rampant Arch* is one whose abutments are on an inclined plane.

A *Relieving Arch* is one on the spandrel of an arch, to distribute and limit the pressure.

A *Skene* or *Scheme Arch*, is a circular arch not over 180°.

A *Skew Arch* is one whose line of direction is oblique with its abutment. See Figs. 309, 310.

A *Straight Arch* is one built with voussoirs, which give a level intrados, used as the head of an aperture in a wall.

A *Splayed Arch* is a funnel-shaped arch; one whose two end sections are unequal.

A *Tweer* or *Tuyère Arch* is an arched opening in a furnace-wall at which the blast-pipe enters.

A *Tymp Arch* is the arched opening at which the metal is discharged from a smelting-furnace.

2. (*Mining.*) An unworked portion of the ground.

Arch-board. (*Shipbuilding.*) The part of the stern over the counter, under the knuckles of the stern timbers.

Arch-brick. A compass brick, or one of wedge shape.

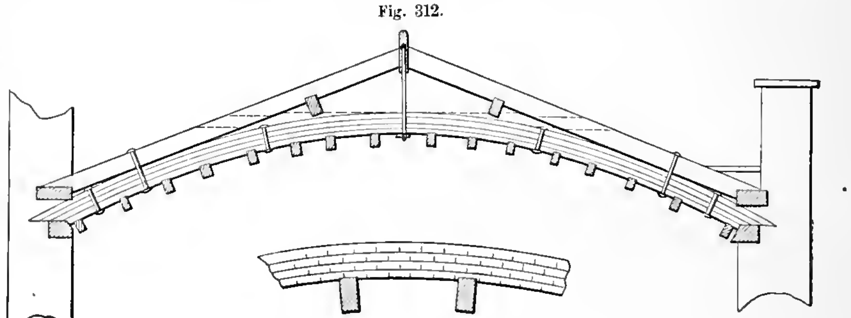
Arch-but'tress. A flying buttress; reaching from the outer wall of an aisle to the clear-story of the nave to form a lateral support against the thrust of the roof.

Arched Beam. (*Carpentry.*) A beam cut, bent, or built into an arched form to support a structure, as a ceiling, roof, or viaduct.

One form of the arched beam is exemplified by the roof of the dining-room of the Charterhouse School, London (Fig. 312). This much-perverted charity is well housed, and the roof of the refectory is formed with circular ribs in four thicknesses of $1\frac{1}{2}$-inch deal four inches wide, with saw-cuts half an inch in depth on the under sides, and put together with *marine glue*, on a cradle center. The dotted lines show the collars, which are dovetailed one inch into the sides of the principal rafters. The principal rafters, being five inches wide, project on one side an inch before the face of the circular ribs, which are only four inches wide. On the collars rest the purlins supporting the rafters. The ceiling joists are spiked up to the circular ribs.

The five main arches of the Ousebourne Viaduct of the Newcastle, North Shields, and Tynemouth Railway, England, are built of arched beams; three

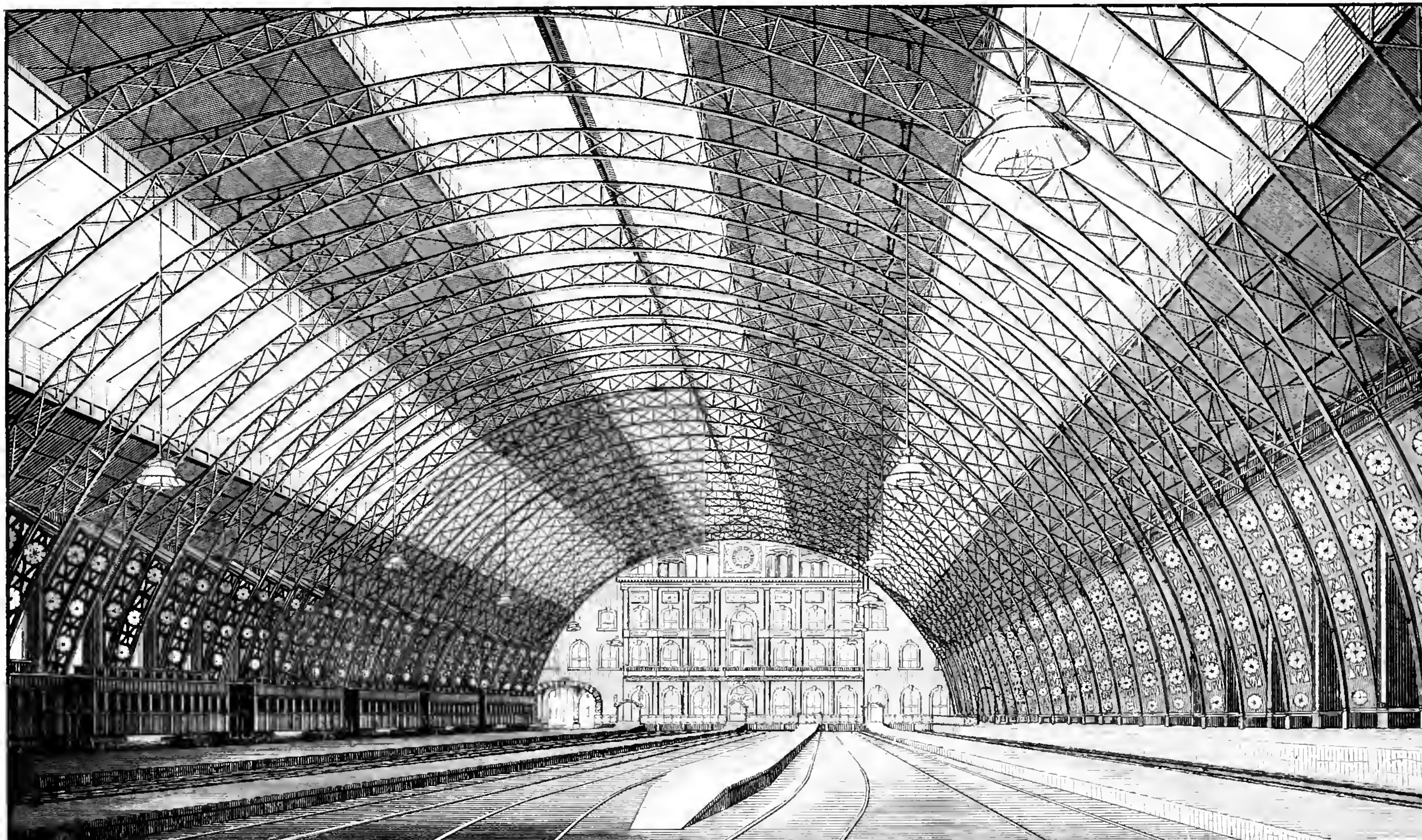
Fig. 312.



Roof over Dining-Room at Charterhouse School.

of these have a span of 116 feet each, and the others have 114 feet span. The hight of the rails above the bed of the stream is 108 feet, and the width of the viaduct is 31 feet, — 26 for a double line of rails, and 5 for a foot-path. At each end of the viaduct are two arches of masonry, and the total length is 918 feet. The two middle piers are erected upon piles from 21 to 27 feet in length. All the piers are of masonry, and tapered upward, the principal being 21 feet wide between the footings and 15 feet at the springing of the arches. The piers are continued upward, of reduced dimensions, to the level of the roadway, the whole of the five main arches, spandreling, and superstructure being formed of timber. The radius of these arches is 68 feet, and their rise or versed sine about 33 feet.

The ribs forming the arches are composed of planks of Kyanized Dantzic pine, the lengths of which vary from 20 to 46 feet, by 11 inches wide and 3 inches thick. The thickness of each rib is made up of fourteen planks so bent as to form an arch, and laid together so as to break joint both transversely and longitudinally. They are fastened together by oaken treenails, $1\frac{1}{2}$ inches in diameter and 4 feet apart, each treenail perforating three of the planks. Between each joint in each direction is placed a layer of strong brown paper dipped in boiling tar.



ARCHED-BEAM ROOF.

GRAND CENTRAL RAILROAD DEPOT, NEW YORK.

PLATE III.

See page 139.

The spandrels are formed of trussed framing, and the platform of the roadway, which is composed of 3-inch planking, is supported upon transverse beams laid 4 feet apart. The platform is covered with a composition of boiling tar and lime, mixed with gravel in applying it, and thus forming a coating impervious to water.

The arched beam has been very extensively used in the timber bridges of the United States. See Wooden Bridge; Arched-Beam Roof.

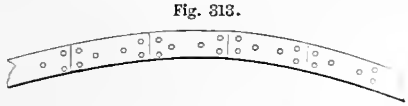
Arched-Beam Bridge. A bridge whose span either consists of a compound beam, or one in which such a beam forms one element in the truss, as in many of the wooden bridges of the last century and the present. See Wooden Bridge.

Compound arched beams of iron are also becoming common, and many beautiful bridges are now made on this principle. See previous article.

The arched beam is now a favorite form of bridge. Angle-iron of varying cross-section is freely used. See Iron Bridge.

Arched-Beam Roof. In the sixteenth century Philibert de Lorme, a French architect, invented an

Fig. 313.



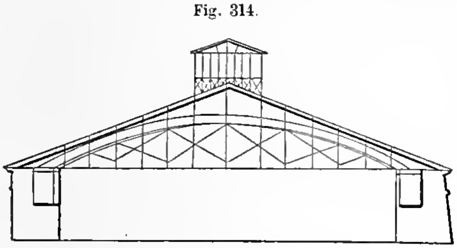
De Lorme's Arched Beam.

arched beam (Fig. 313) made of pieces of timber which were cut into short arcs of the required circle, placed edgewise, and bolted together, breaking joint. Several roofs in Paris and London are, or were, of this construction.

It was a disadvantage of this plan that the pieces were necessarily short, as they would otherwise present a cross grain to the strain.

The largest roof of one span, in its day, was that of the Imperial Riding-House at Moscow, built in 1790

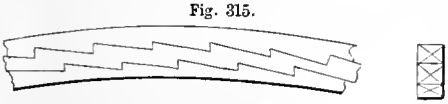
Fig. 314.



Imperial Riding-House.

(Fig. 314). The span is 235 feet. The members of the arched beam are notched together (Fig. 315) so as

Fig. 315.

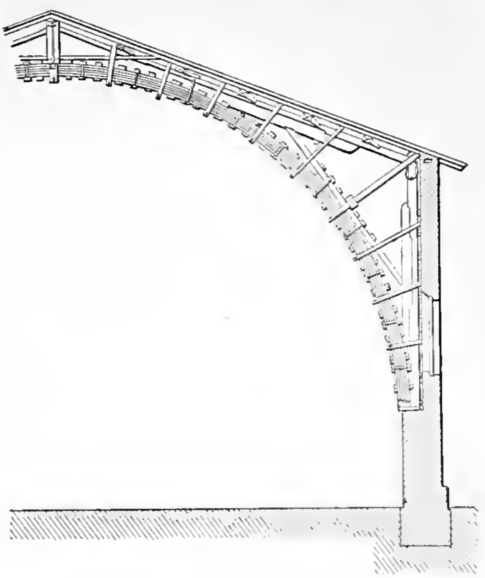


Notched Arch-Beam.

to prevent slipping on each other. The ends of the arched beam are prevented from spreading by a tie-beam, and the arch and tie are connected together by vertical suspension-rods and diagonal braces.

Colonel Emy's arched beam (1817) is constructed on a principle differing from both of the foregoing (Fig. 316). The ribs in this roof are formed of planks bent round on templets to the proper curve, and kept

Fig. 316.



Emy's Arched-Beam Roof.

from separating by iron straps, and also by the radiating struts which are in pairs, notched out so as to clip the rib between them.

The principals, wall-posts, and arched rib form two triangles, firmly braced together, and exert no *thrust* on the walls; the weight of the roof, being thrown on the walls at the feet of the ribs, and not at the pole plate, permits the upper portion of the walls to be comparatively light.

The Colonel erected a roof of this description in 1825 at Marac, near Bayonne.

The principle has been extensively adopted in wooden bridges in the United States and in Europe. See Wooden Bridge.

The illustration opposite represents the roof of the Union Passenger Depot of the New York and Harlem Railway, projected by Commodore Vanderbilt, and constructed from the designs of J. C. Buckhout, C. E. The roof is 652 feet long and 199 feet 2 inches between walls. It is supported upon 32 semicircular trusses, which are spaced 20 feet 4 inches between centers, extending from a point 2 feet below the rails to an elevation of 94 feet from the springing line to the extrados of the arch. Each truss has at its foot two tie-rods $2\frac{1}{4}$ inches in diameter, with a turn-buckle at the mid length. The pitch of the roof is formed by rafters secured to the top chord of the arch.

The trusses weigh about forty tons each, and were raised in sections by means of a movable staging 80 feet high, 160 feet long, and 30 feet wide, moving on ways, and shifted along step by step as the work of raising the trusses progressed. About 8,000,000 pounds of iron were used in the structure, 10,000,000 bricks, 20,000 barrels of cement.

The car-house is lighted through three skylights, extending over the entire length of the roof, — one on the center, double-pitched, and a single one on each side of the center, and having altogether 80,000 square feet of glass, — nearly two acres. The north end is closed by an iron front, the south end by the building containing the principal offices of the Company.

The roof covers nearly three acres, the station itself about four acres. The station is designed for the use of the Hudson River, Harlem, N. Y. Central, and N. Y. and New Haven Railways, having lines of rail for each company, besides those for the Fourth Avenue horse-cars which run into and to and from this station, which was opened for traffic October 7, 1871. The gas-burners of the building are lighted at night by electricity ; 25,000 feet of electric wire being used, and 20,000 feet of gas-pipe. The 144 steam-radiators are heated by 15 miles of steam-pipe.

The roof is ventilated by six lines of ventilating slats 6 feet high and 8 inches wide, with a Z-shaped interval between the slats.

The roof of the St. Pancras Station of the Midland Railway, England, covers nearly four acres. The roof had at the time of its erection, and may yet have, the widest span of any in existence, 240 feet, and the space beneath is unbroken by ties or braces. Its style is subdued Gothic, with segments meeting at its crown. The roof springs from the platform level, the principal ribs each having the form of a four-centered arch, the radii of the curves being 57 feet and 160 feet respectively. The two central curves — those of 160-feet radius — meet at an angle in the center at a hight of 96 feet above the platform level. The length of the roof is 690 feet, with a clear span of 240 feet, covering five platforms, ten lines of rails, and a cab-stand 25 feet wide, thus making a total area of 165,600 square feet. Its hight at the ridge is 125 feet above the level of the road. There are twenty-five principal ribs in the roof, 29 feet 4 inches apart from center to center, and each weighing about 50 tons. The station walls rise, behind the spring of the principal, the space at the top being filled in with open ironwork.

The roof is glazed about 70 feet on each side of the center, and the remainder is covered with slates.

The transverse girders which support the floor of the station take the thrust of the roof. They are connected so as to form continuous girders across the station, and rest on the walls of the 17½-feet story beneath. Besides being tied to the girders, the feet of the ribs are each secured by four 3-inch bolts to an anchor-plate built into the wall and strongly fastened.

Arched But′tress. A flying buttress, or *arc-boutant.*

Ar′chil. The extract of Orchilla weed, used for dyeing, usually evaporated so as to form a solid mass like indigo. Called also *Orchil* and *Cudbear.*

Ar′chi-me-de′an Drill. A drill whose stem consists of twisted pinion wire, or a core having steep spirals. A nut with internal oblique grooves is reciprocated on the stem and rotates the latter. A PERSIAN DRILL (which see).

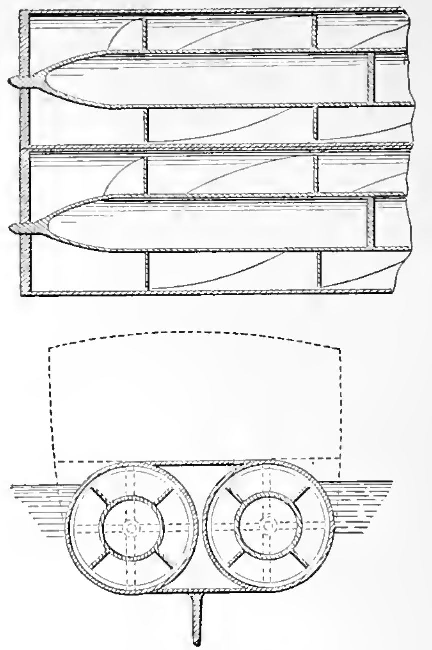
Ar′chi-me-de′an Pro-pel′ler. A propeller consisting of a continuous spiral vane on a hollow core running lengthwise of the vessel. It is an amplification and extension of the screw. Figure 317 shows it in horizontal and transverse sections. See SCREW PROPELLER.

Ar′chi-me-de′an Rail′way. A form of railway in which a continuous shaft rotates on pillars erected between the lines of rail, the shaft having a spiral rib which acts as a screw upon a pedestal below the car to propel it along the track.

Ar′chi-me-de′an Screw. The invention of Archimedes when in Egypt, about 260 B. C. It consists of a hollow inclined screw, or a spiral pipe around an inclined axis ; the lower end is submerged in the water and the upper end discharges.

Strabo refers to a water-raising machine of this kind, used to supply the garrison of the Memphite Babylon, on the Nile, and worked by 150 men.

Fig. 317.



Archimedean Propeller.

It was also used as a draining pump by the Turdetani of Iberia in the time of Strabo. This was the country of the Guadalquiver. See SCREW, ARCHIMEDEAN.

Ar′chi-tect′ure. The classic orders are five : *Doric, Ionic,* and *Corinthian* (*Greek*) ; *Tuscan* and *Composite* (*Roman*). The more modern is *Gothic,* which has several varieties : *Anglo-Roman,* B. C. 55 to A. D. 250 ; *Anglo-Saxon,* A. D. 800 to 1066 ; *Anglo-Norman,* 1066 to 1135 ; *Early English or Pointed,* 1135 to 1272 ; *Pure Gothic,* 1272 to 1377 ; *Florid,* 1377 to 1509 ; *Elizabethan,* 1509 to 1625. The subject is copiously and admirably treated in many excellent works. Its interest in a work of this character is not as an art, but as requiring machinery to hew and shape the stones, construct the foundations and the roof, and also calling for ingenuity in providing the building with its material accessories for safety, ventilation, warmth, light, and convenience.

The following are dates assigned by some authorities for the buildings mentioned : —

The Pyramids (about)	B. C.	1500
Memnonium	"	1350
Solomon's Temple	"	1004
Birs Nimroud,	"	900
Jupiter Capitolinus	"	616
Parthenon	"	438
Pantheon	A. D.	13
Coliseum	"	70
St. Sophia	"	532
Mosque of Omar, at Jerusalem	"	637
Caves of Ellora	"	700
St. Peter's, Rome	"	1626
St. Paul's, London	"	1710

The *tent* is the original of the Chinese style.
The *cave* is the original of the Egyptian.
The *log cabin* suggested the Grecian.
The *avenue of trees* the wondrous Gothic nave.
The possession of iron and various facilities of

work have yet inspired no one. Some are anxious to build iron houses as much like stone as possible; the most ambitious attempt is an immense barn at Sydenham, England, — an engineering success, but not a work of inspiration.

The Egyptian capitals were the prototypes of those of the Grecian and Roman orders; and the various ceramic works of the Greeks and Etruscans were strangely like those of the Nile people. The opening of the Egyptian ports by Psammeticus, 670 B. C., was fortunate for the nations on the northern shore of the Mediterranean.

For Specific Index of ARCHITECTURE, see MASON'S AND BRICKLAYER'S WORK.

Ar′chi-ton-nere. A name for the STEAM GUN.

Ar′chi-trave. (*Architecture.*) That portion of an entablature which rests upon the columns; the *lintel.*

(*Carpentry.*) The molding around a doorway or window. The respective portions are known as the *transverse architrave*, and *architrave jambs.*

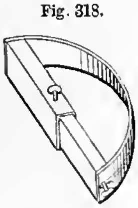
Ar′chi-volt. (*Architecture.*) *a.* A molding running round the face of an arch.

b. The inner curve formed by the voussoirs or arch-stones.

Arch′-stone. A wedge-shaped stone used in an arch; a voussoir. In some furnaces the chamber, or an opening thereinto, is covered by a flat ashlar, which is called an arch-stone.

Arc′o-graph. An instrument for describing arcs of circles without the use of centers. A thin and pliable strip of metal whose ends are attached to the wooden bar may be sprung into the required shape and then fastened by set screws. Unless the stock have means for extension and contraction, the range of arc which may be described will be but limited. The device is susceptible of many variations, and is useful as a templet or marker for many purposes.

Fig. 318.



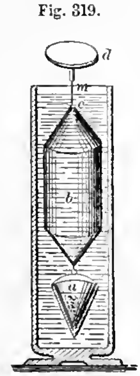
Arcograph.

A-re-om′e-ter. An instrument used by the Spanish Saracens A. D. 1000. It had a bulb and stem similar to a hydrometer; floating in liquid, its stem was more or less submerged by the changes in the density of the liquid due to changes of the temperature, and thus constituted a thermometer.

NICHOLSON'S areometer consists essentially of the funnel *a*, the cylinder *b*, rod *c m*, and the table or plate *d*.

The instrument is so arranged that when set in distilled water and a definite weight laid upon *d*, it will sink to a mark *m* made on the rod. To determine the specific gravity of a mineral, it is laid on the plate *d*, when it will of course depress the instrument in the water. Additional weights must be added to bring the mark *m* to the level of the water, and the amount of these subtracted from the standard weight already referred to will be the weight of the mineral in the air. Call this weight *p*. Remove the mineral from the plate, and place it in the funnel or hollow cone *a*; immersed in the water the areometer will not sink quite to *m*, say about to *c*, the body losing in water an amount of weight equal to that of a quantity of water of precisely the same volume with itself, that is, equal to that of the water displaced. Additional weights are now to be laid on *d* until the level *m* is again reached. This amount, which we will call *p*′, expresses the weight of an equal volume of water. We have thus ascertained the weight of precisely equal volumes of water and of the mineral, and as water is the standard taken, $\frac{p}{p'}$ will express the ratio of the two, or the specific gravity of the body.

Fig. 319.



Nicholson's Areometer.

Thus, $x : 1 :: p : p'$, and $x = \frac{p}{p'}$.

The areometer of PAPPUS, the Greek philosopher contemporary with Theodosius the Great, A. D. 379–395, is described by Al-Khâzinî the Saracen, an eminent writer of the twelfth century, the author of the "Book of the Balance of Wisdom," and suspected to be identical with the great Al-Hazen, whose celebrity is associated with the Cordovan period of Spanish history. It was a graduated brass tube which floated vertically in liquid and indicated by the line of submergence the degree above or below the "equator of equilibrium," the specific gravity of the matter weighed.

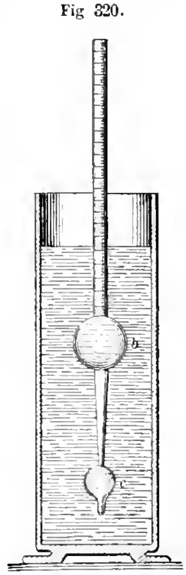
The surmise of Chev. Khanikoff, indorsed by Draper, that Abu-Jafar Al-Khâzini and Al-Hazen were identical may be correct. They were certainly contemporaries, but the former, whose name it is impossible to find in any other part of the Persian annals, fails in some respects to answer for 'Abu-'Alî Muhammad Bin 'al-Hasan 'Ibu 'al-Haitham, said to be of Basrah.

The book referred to above as the writing of Al-Khâzinî was composed, as is seen in the Dedication, at the court of the Saljûke Sultân Sanjar, who reigned over a large part of the ancient Khalifate of Baghdâd from A. D. 1117 to 1157.

The areometer of Pappus is very similar to the *Volumeter* of Gay Lussac.

GAY LUSSAC'S scale areometer consists of a cylindrical glass tube in the lower part of which a ball *b* is blown, and, being continued, finally terminates in another ball *c*. The latter is filled with shot or mercury, to cause the instrument to sink vertically in distilled water to a certain point, the zero. The specific gravity of a liquid is ascertained by the depth of depression, its weight being equal to that of the liquid displaced. It is a form of hydrometer.

Fig 320.



Gay Lussac's Areometer

A-re-o-sty′los. An intercolumniation of four diameters width.

Ar′gand Gas′-burn-er. The Argand Gas-burner has a circular series of holes on the upper edge of a cylindrical chamber, having a central aperture to allow access of air to the inside of the flame.

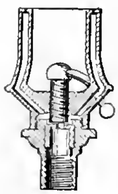
The jets from the series of holes unite to form a cylindrical flame. The holes are about one sixth of an inch in diameter, and when there are ten holes in the circle, the middle opening will be four tenths of an inch in diameter; with twenty-five openings, the central aperture will be about one inch in diameter.

The following formula is given for the number of holes, central aperture, hight of flame without smoking, and appropriate size of chimney: —

No. of Apertures.	Central Opening.	Hight of Flame.	Diameter of Glass Chimney.
	inch.	inch.	inch.
10	$\frac{3}{8}$	$3\frac{1}{2}$	$\frac{8}{10}$
15	$\frac{1}{2}$	3	$\frac{12}{10}$
20	$\frac{3}{5}$	$2\frac{1}{2}$	$\frac{18}{10}$
25	$\frac{19}{20}$	2	$\frac{15}{10}$

In Fig. 321 the lower section of the burner has an orifice for the gas, which is more or less obstructed by the end of a screw which is either turned directly by hand, or, when vertical and inclosed within the burner, is turned by a lever projecting through a slot therein.

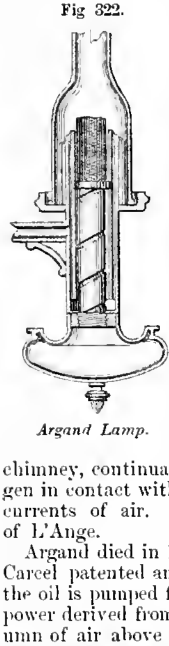
Fig. 321.



Argand Gas-Burner.

Ar'gand Lamp. Invented by Argand, a native of Geneva, about the year 1784. It consists of two concentric cylindrical tubes between which is fitted the annular wick used in this peculiar burner. The annulus inclosing the wick is closed at the bottom, and communicates, by a pipe, with the oil reservoir. The interior tube being open, free access of air is allowed to the interior and exterior of the flame, insuring more equal and perfect combustion.

Fig 322.



Argand Lamp.

In a round solid wick, burning any of the fatty oils, such as sperm, a large proportion of the carbon, which in that class of oils is greatly in excess of the hydrogen, escapes unconsumed and is wasted, rising in the form of smoke.

The annular wick has double the surface of a solid one of the same diameter exposed to the contact of the atmosphere, and as the flame is also thinner its temperature is more uniform, and the vapor from the center of the wick is consumed equally with that from its exterior. The combustion is also greatly aided by the draft caused by the glass chimney, continually bringing fresh supplies of oxygen in contact with the flame and protecting it from currents of air. The chimney was the invention of L'Ange.

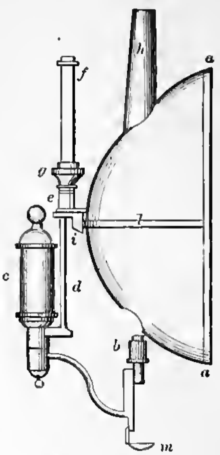
Argand died in 1803. A French mechanic named Carcel patented an improvement in 1800, in which the oil is pumped from the reservoir to the wick by power derived from a spring or by the ascending column of air above the chimney. This is called the *Mechanical Lamp*, and is used in the large lamps for the Dioptric system in lighthouses.

The Argand burner as modified by Fresnel for the Dioptric system in lighthouses has four concentric wicks, the outer one $3\frac{1}{4}$ inches in diameter, and the great heat produced is carried off by two means, — overflowing the wicks with oil, and by means of the ventilator devised by Faraday. The oil in superabundant quantity is pumped into the wick-tubes and flows over the top. The ventilator is a tube having several sections, the lower portion of each being flaring, and receiving the upper end of the section below, which enters it a short distance. The top of the lamp-chimney enters the lower section and produces a great draft.

The Argand lamp first made effective the Catoptric system for lighthouses.

The annexed engraving shows the lamp in its lower position, withdrawn from its place in the focus of the paraboloid reflector *a* for trimming. *b* is the burner, and *c* a cylindrical fountain containing twenty-four ounces of oil. The oil-pipe, burner, and fountain are connected to a frame *d*, which is movable in a vertical direction upon guide-rods *e f*, by which it can be let down by simply turning the handle *g*.

Fig. 323.

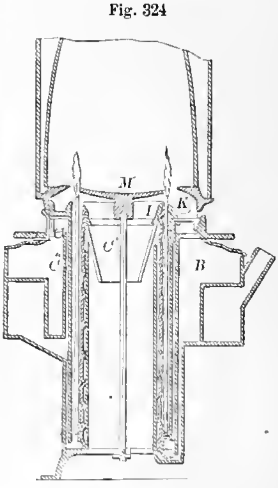


Argand Lamp.

An aperture of an elliptical form, measuring about two inches by three, is cut in the upper and lower part of the reflector, the lower serving for the free egress and ingress of the burner, and the upper, to which the copper tube *h* is attached, serving for ventilation; *i* shows a cross-section and a back view of the main bar of the chandelier or frame on which the reflectors are ranged, each being made to rest on knobs of brass, one of which is soldered to the brass band *l*, that clasps the exterior of the reflector. *m* is an oil cup to catch drip. A frost lamp is placed at this point in winter to keep the oil in the wick-tube in a flowing condition.

The tubular wick-burner (Fig. 324) has a water-chamber *B C''* interposed between the wick-tube and the oil-reservoir, so as to prevent the heating of the contents of the latter. The wick occupies an annular space formed by two concentric wicks. *M* is the deflector plate, and *C' I* a frustrum to reflect upward the heat which reaches the inside of the tube. *G''* is a perforated floor to prevent the conduction of flame, on the principle of Davy's safety-lamp. The water has an overflow down the central air-tube. *K* is the base ring for the chimney.

Fig. 324



Dopp's Argand Lamp.

Ar-gent'al Mer'-cu-ry. Silver amalgam.

Ar'gen-tan. An alloy of nickel copper and zinc. ALBATA; GERMAN SILVER (which see).

Ar'gen-tine. White metal coated with silver.

Ar'gen-tine Glass. An ornamental glassware having the sheen of silver. It is the invention of Apsley Pellatt, and is formed by inclosing delicate white Argentine incrustations of dry porcelain clay with solid and transparent glass.

The dry figures are placed on a red-hot bulb of flint glass and immediately covered with a thin layer of very fluid glass.

The exterior layer is polished, and gives a silvery brightness to the white figure.

Ar-gen-tom'e-ter. A graduated tube used for ascertaining the amount of silver in a solution by the admission of a definite bulk of chloride of sodium solution.

Ar-gen'tum Mo-sa'i-cum. An alloy, or rather *amalgam*, of tin, bismuth, and mercury, used for coloring images of plaster of Paris. *Argentum Musivum.*

Ar'gil. Potter's clay, from the Latin *argilla*; white clay.

Ar'go-sy. A merchant-ship of the Mediterranean; specially of the Levant. The term is now antiquated.

A'ri-es. The battering-ram, so called because the metallic head of the beam was sometimes fashioned like the head of a ram. As a means of battering walls it is said to have been invented by Artemanes of Calzomene, a Greek architect, abont 441 B. C. It is described by Josephus, who states that it was sometimes supported on the shoulders of men who advanced on a run; at other times it was slung from a frame, and operated by ropes.

Philip of Macedon is said to have been the first to place the frame on wheels, at the siege of Byzantium. Plutarch informs us that Marc Antony, in the Parthian war, made use of an aries 80 feet long. Vitruvius says they were sometimes 106 to 120 feet in length.

A-rith-mom'e-ter. An instrument for assisting in calculating. The most ancient form is the Abacus (which see). This has a series of wires, the balls on which represent units, tens, hundreds, etc., and is used by sliding the balls on the wire, to tabulate the result of each successive increment or decrement of numbers.

If the balls were numbered and several series were strung upon a ring, they might be passed continuously in the same direction, as the addition required.

The Arabs, to whom we are indebted for the introduction of the Indian numerals, termed their treatises "Systems of *Indian* Arithmetic." The word *cipher* is the Arabic *tsaphora*, — "blank" or "void"; alluding to its integral value. The word *algebra* is also Arabic. The words *chemise, cotton,* are also Arabic, and to the Arabs Europe is also indebted for the introdnction of the garment and the material. Mohammed Ben Musa wrote a treatise on algebra in the latter part of the ninth century. The Khalif Al-Maimon measured a degree of latitude on the Red Sea shore. This, when the teachings of Constantinople and Rome were on the scale and standard of Byron's Grand Seignoir, —

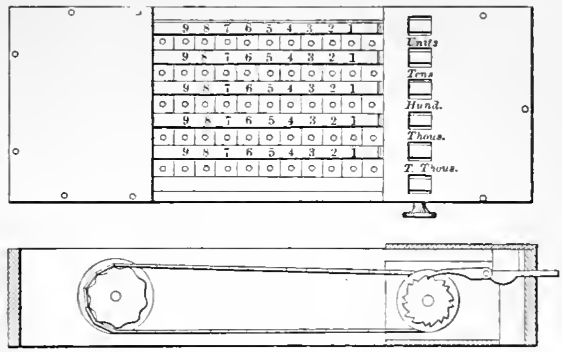
"He knew, because he saw, the moon was round,
Also was certain that the earth was square." — *Don Juan.*

An arithmometer was suggested by the Marquis of Worcester in his "Century of Inventions," but was not described. It was adapted for addition and subtraction.

Sir Samuel Morland, in 1672–73, published a treatise on the use of two arithmetical instruments adapted for addition and subtraction.

In Fig. 325, instead of balls on a wire, a series of sectional belts operate numbered wheels, which are rotatable in one direction only. The numbers on the peripheries of the wheels are exposed at a row of openings in the case. The sections of the belt are perforated so as to be moved by a peg, the selection of the place for the peg being assisted by a row of numbers over each belt.

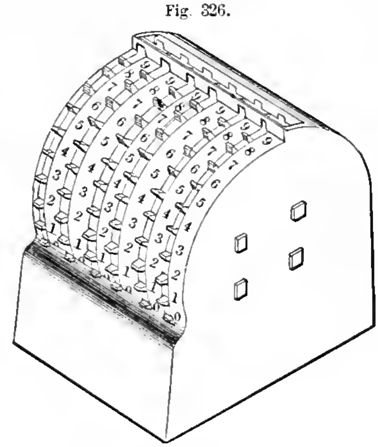
Fig. 325.



Computing Machine.

The Calculator (Fig. 326) has disks numbered on their peripheries and arranged on a common axis.

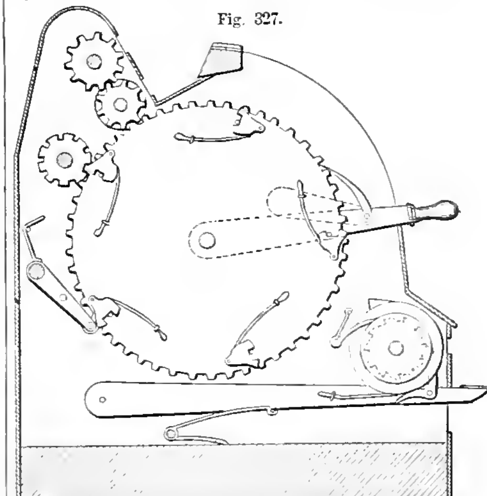
Fig. 326.



Calculator.

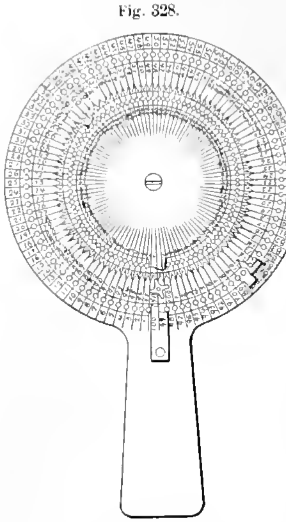
They are moved by cogs exposed conveniently to be operated by the finger, and are so connected that

Fig. 327.



Arithmometer.

Fig. 328.



Disk Arithmometer.

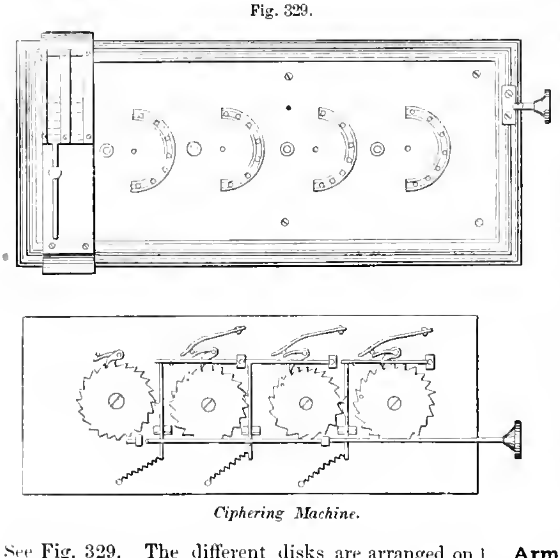
the motion of ten cogs on the disk of units gives the next disk a single impulse and registers ten, and so on through the series. The result is visible at a slit in the case.

Fig. 327 has also the numbered disks, which are moved by handles sweeping in circular arcs. It performs the operations of addition, subtraction, multiplication, and division, the results appearing at different slits in the case. Space will not permit an exact elucidation of the mode of operation of this ingenious machine.

Another form of arithmometer is that in which disks of varying diameters overlie each other, and communicate motion to each other in regular series, as in Fig. 328, the units to the tens, these to the hundreds, etc. The principle is substantially the same as those previously described, but the device has a compact appearance, and the result is read on a dial.

One other form is analogous to the disks of a gas-meter register, which is in fact an arithmometer.

Fig. 329.



Ciphering Machine.

See Fig. 329. The different disks are arranged on their separate axes, and usually have their numbers on their circular faces. A revolution of the unit wheel gives one tenth of a revolution to the wheel registering tens, and so on; the numbers of the wheels appear at the series of openings in the slit, and are read consecutively. In the gas register the impulse is all imparted to the unit wheel, and from it is transmitted through the series; but in adding machines each wheel must have capacity for independent rotation to register thousands, hundreds, tens, and units, not affecting those below it of lesser denomination, but each imparting to the one above it one tenth of its own motion.

Registering devices are to be seen very perfectly constructed in steam-engines and printing-presses; in the former to record the number of revolutions of the shaft for economical purpose in estimating the consumption of steam, the slip of the paddles, etc., and in the latter case for keeping record of the number of impressions. See CALCULATING MACHINE, BABBAGE'S.

Ark. A flat-bottomed boat made of a frame and boards which do not usually overlap, but are nailed to the frame and have the interstices calked or daubed.

It is used on the Western rivers to transport produce, pelts, merchandise, etc.

Ar-lien-ans'e. (*Fabric.*) A kind of Spanish linen.

Arm. (*Angle-Iron.*) 1. One of the wings or flanges of angle-iron. The side-arm of the angle-iron in a ship's frame forms the *faying*-surface to which the plates are riveted. The other arm is in the plane of the transverse section of the vessel.

2. (*Knees.*) One of the members or projections of a *knee*. With *timber* knees, the arms are usually two, resting respectively against the *beam* and the ship's sides. With *iron* knees, the arms may be more numerous, and may embrace other sides of the object to which they appertain.

3. (*Nautical.*) One of the projecting members of an anchor, terminating in a *fluke* or *palm* which takes hold on the ground.

The *arms* unite at the *crown*.

The *throat* is at the junction of the inner edge of the *arm* with the *shank*.

The *trend* is that part of the *shank* reaching from the *throat* towards the *stock*, a distance equal to the length of the *arm*.

The *pee* or *bill* is the point of an arm.

4. The outer piece of an overshot water-wheel bucket. Also called the wrist. The inner piece is the *floor* or *bottom*. See BUCKET.

5. (*Vehicles.*) That part of the axle which passes through the hub of the wheel. The *axle-spindle*. When of wood, it is strengthened by metallic straps called *skeins*, and sometimes by a conical sheath called a *thimble-skein*.

In carriages it is of iron, in continuation of the iron axle, or it is inserted into the end of a wooden axle. See AXLE.

6. Of a hammer. The handle of a trip-hammer, which receives the impulse of the cams.

7. Of a windmill. The beam which supports a sail; the sail itself; also called a *whip*.

8. A spoke of a gear-wheel.

9. An end of a yard.

10. A weapon; as, *side-arm*, *fire-arm*, *small-arm*.

Arm, Ar-ti-fi'cial. Artificial arms are adapted for amputations above or below the elbow, respectively. In the former case the movements, in the most perfect artificial arms, are derived from the motions of the stump; the backward motion of the latter extending the joints of the prosthetic arm and hand, and the forward motion of the stump flexing the said joints. These motions are derived from bars or cords which connect the forearm to a shield on the shoulder, as in Koeller's, or to bands on the body, as in Condell's and in Uren's.

In these cases the upper arm consists of a socket to receive the stump of the limb, and is secured by straps to the person with a certain degree of rigidity. The anterior and posterior tendons or rods have a firm attachment at or near the shoulder, pass along or through the upper section, and are attached to such points on the forearm that, as one or the other is tightened, the forearm is flexed or extended. In some cases the oscillation or the elbow-articulation is obtained by cords which have direct or intermediate attachment to the forearm, as in Condell's and Peterson's; in others the cords or bars move a toothed wheel which engages a pinion on the elbow axis and gives motion to the forearm, as in one of Koeller's.

The backward motion of the stump, it will be apparent, tends to strain the anterior tendon, which is so connected to the forearm behind the elbow-joint as to extend the forearm. The forward motion of the stump strains the posterior tendon which connects to the forearm in front of the articulation, and thus flexes it as the stump is moved forward. These motions follow the natural ones, as, for instance, in the act of raising the hand to the mouth it is usual to oscillate the arm forward on the shoulder as a pivot, and backwardly as the hand descends. In the natural arm the pivotal position of the forearm is varied so as to cause the said arm to swing in an arc which will bring the hand to the required place, say the mouth, for instance; in the artificial arm, the motion on the shoulder is the generator of the motion on the elbow, and a certain amount of practice and adjustment is required to proportion the parts so that the consentaneous action of the parts which produce the compound motion may, without apparent constraint or indecision, land the hand at the object. When the trunk of a person affords points of attachment for the flexor and extensor straps, the motions of the shoulder itself, relatively to the thorax, and involving the clavicle and scapula, may be made to assist in executing the motions required.

The primary motion of the stump having been communicated to the forearm by the means described, (and the special devices are various and very ingenious,) the motions of the hand are derived from that of the forearm by means of tendons, slides, or other attachments. The construction will farther appear when considering some of the varieties of artificial arms, though it will not be possible to afford space for an exhaustive description even of the sixteen patents which have been selected and are now before the writer.

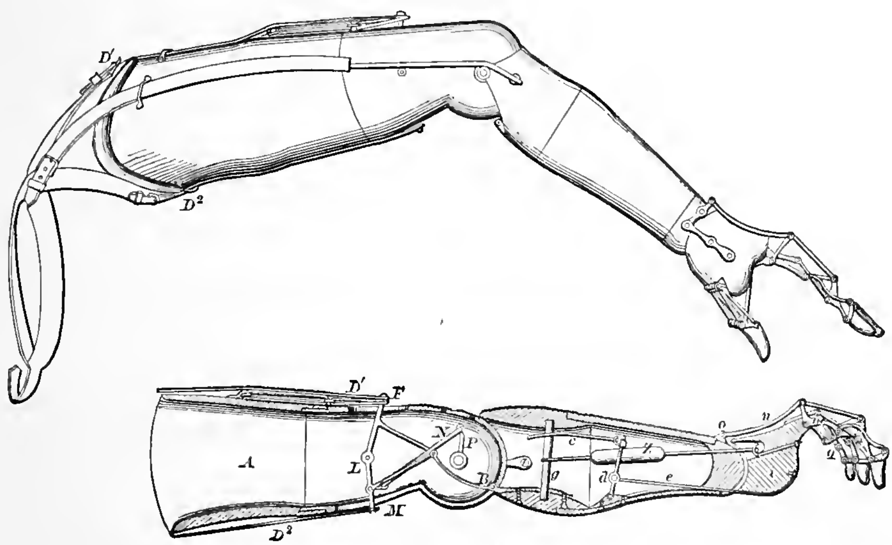
One class of arms does not receive motion from the stump, but retains the position at which it is set by the other hand, or assumes and retains it by swinging it in one direction or the other till it is engaged by a spring latch. Drake's, also Lindsay and Vance's, are illustrations of the former; Lincoln's of the latter.

To secure the requisite lightness and afford room for the operative devices, artificial arms are made hollow. The material is various, and some patents have been issued for the use of specific materials, such as rawhide, which has a toughness and strength hardly to be excelled. Vulcanite, papier-maché, layers of fabric alternating with glue, veneers, card-board, and hollow wooden blocks shaped to the natural contour, have all been advocated and used.

The tubular form does not always extend to the metacarpus, and the fingers especially are frequently made of solid jointed blocks, with tendons, cartilage, and ligaments. These prosthetic parts perform the functions of their correlatives, as being the means of motion, giving resiliency to the contact of the parts, and specific connection to the phalanges. In the latter case, the hingeing of the parts, it must be admitted that the human mechanic has assumed a hard task in attempting to copy the natural articulations, and that he has done commendably with the materials at hand.

In CONDELL'S arm the loop appendage is a yoke of webbing for the attachment of the socket to the stump, and for securing such a rigid connection to the body that the three straps proceeding down the humerus may be utilized when the stump is moved backward, forward, or rotated, in producing extension

Fig. 330.



Condell's Artificial Arm.

and flexion of the arm and the forward motion of the metacarpus which opens the phalanges. The axis moves with the forearm, and a stud *P* thereon affords a point of attachment for the spring *N*, whose duty is to assist in extension. The straps D' D^2 are respectively attached to the yoke in posterior and anterior positions, and to the arm of the rock-shaft *L* at *F* and *M* respectively. The draft on D' acts to flex, and on D^2 to extend, the forearm, by means of the link *B*, which is pivoted to the forearm anteriorly. The flexor and extensor motions described apply to the forearm, but do not involve the action of the hand, the metacarpus of which is hinged by a through pin to the mid-wrist. A post *g* is permanently attached in the hollow of the arm, and a spring tendon *Z* passes from it to a point on the metacarpus back of its wrist articulation, so as to oscillate it backwardly. This spring being constant, the normal position of the metacarpus is rearward and the fingers and thumb closed. The relation of the motion of these to that of the metacarpus will be presently described. The forward motion of the hand and the opening of the grasp are effected by a slight rotation of the shoulder, which draws upon the strap *c*, oscillates the post *d*, and by means of the tendon *e* draws forward the metacarpus extending the phalanges.

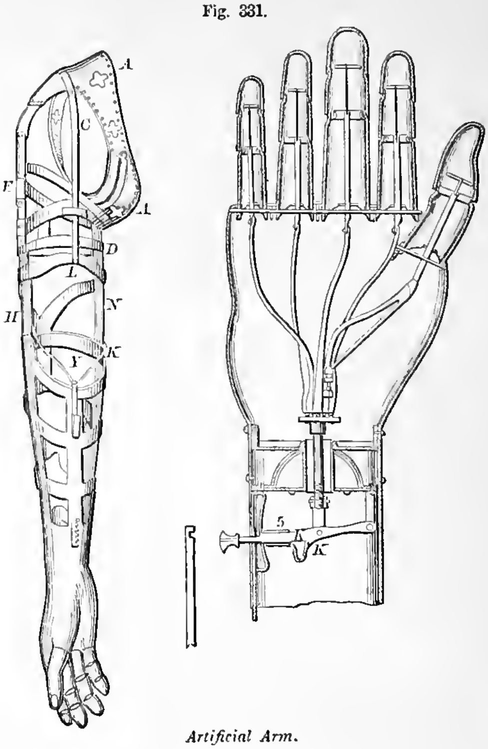
The forward portion of the forearm is sleeved upon the butt or wooden part in which the post *g* is secured. By the partial rotation of the forward portion the ulna-radial motion is given (by the other hand), to vary the presentation of the palm ; the tendons which actuate the metacarpus still maintaining the same relation, that is, having their points of attachment thereto at opposite sides of the axis of vibration.

The frame-piece *m* of each finger is pivoted to a point on the metacarpus *i*, and the rod at the back of the hand is pivoted to the frame-piece and also to a point on the forearm at *o*, so that when the metacarpus is moved, by the means previously described, the frame *m* is oscillated on its pivot, and gives the primary deflection to the finger. The second section of the finger-frame is pivoted to a point on the frame *m*, and is connected by a link to a stud permanently attached to the metacarpus ; by this means is obtained the additional deflection proper to the second phalange. The additional deflection due to the third phalange is given by a rod attached to it and to the frame-piece *m*. The same arrangement is adopted for each finger, and the action of the phalange is cumulative, the second and third phalanges participating in the motion of the first, and having an additional motion derived therefrom ; the third in like manner participates in the motion of the second and third, and has a motion of its own derived from its predecessors. The proportion of the parts of respective fingers is so regulated that, in closing, the second, third, and small fingers receive a gradually accelerated motion in the order stated, so as to imitate the natural closure of the hand, in which the little finger most nearly approaches the palm and the others stand in receding order.

The motions of the thumb are substantially equivalent, being derived from its diverse points of attachment to the metacarpus and to a point on the forearm, so as to be closed by the backward motion of the former, and conversely, as already stated in regard to the phalanges of the fingers.

In Fig. 331 the shoulder-cap is the basis for the movements of the arm, forearm, wrist, thumb, and fingers. The strap C is hinged to the cap *A*, and connected by a rod to the ring *L*. The straps *D E* of the upper arm are also hinged to the cap and the lower part of the upper arm ; from the ends of the straps *D E* proceed the slotted bars *H N*, to whose

Fig. 331.



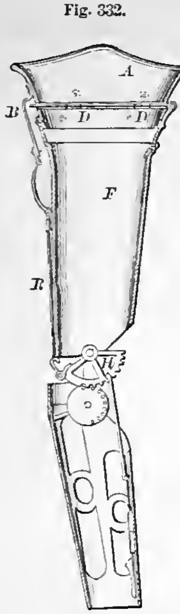
Artificial Arm.

lower end the forearm is pivoted. The three straps mentioned are the means of suspension of the arm, forearm, and hand, and the stump of the natural arm within this outer skeleton is the means of imparting motion to the forearm, wrist, and fingers. The ring *L* is connected to the strap *C*, and hinged to the forearm behind the elbow-joint ; it is guided in its motions by the slotted bars *H N*, sliding down the said slots as the stump is moved forward, and thereby thrusting upon the point of the elbow and flexing the forearm.

Pivoted to the bars *H N*, near the elbow-axis, are the bifurcated ends of the wire *Y*, which actuates the fingers and thumb, flexing them as the arm bends, by means of tension on the tendons which pass through the metacarpus and then diverge to follow the phalanges. By means of the lever *K*, the spring-slide 5, and the notched slot, the thumb and fingers can be connected to or disconnected from the arm and forearm, so as to receive motion therefrom, or otherwise as may be desired. In the rotary movement of the stump the upper end of the strap *D* runs on a rod attached to the shield *A* under the axilla.

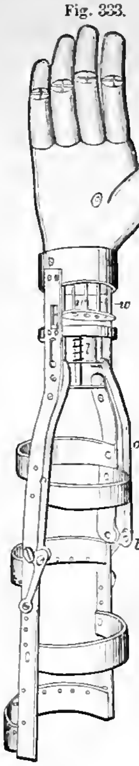
Fig. 332 is for amputations above the elbow. The shoulder-joint is imitated by a cap or collar and a hoop which turns on the collar by looped brackets, which slide upon a wire ring suspended to the lower edge of the collar. The case which holds the stump is attached to the hoop by a hinged joint, and turns with it. The motions of the stump, whether rotary or back and forth, turn the hoop, and by means of a system of jointed levers, the fixed points of which are on the collar, and the case for the stump, motion is

Fig. 332.



Artificial Arm.

Fig. 333.



Artificial Arm.

communicated to a segment-wheel at the elbow-joint to which the levers are attached, and this wheel, acting upon a pinion on the forearm, causes it to be flexed and extended according to the motions of the stump.

The hoop *D D* slides on the collar of the artificial shoulder *A*, the two portions being bracketed to a ring *B* between them. The hinge motion of the shell *F* of the upper arm is effected by the stump, and the segment-gear *H*, being linked posteriorly to the shoulder-piece, is rotated by the motions of the upper arm, which tighten or slacken the said link-connection *R*.

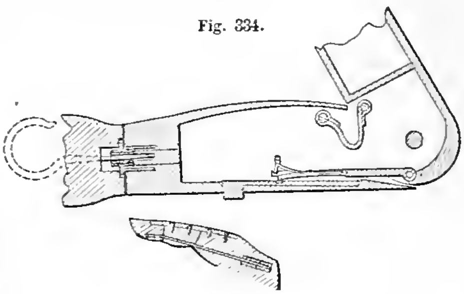
In Fig. 333 the flexion of the forearm operates the fingers, and the spring in the wrist tends to close them. To studs *b* on the upper arm are attached rods *o o*, which connect with a sliding plate in the wrist, to which the flexor rods *w w* of the fingers are attached. The elbow connection of the rods *o o* is in the rear of the elbow articulation of the limb, and the forward motion of the forearm draws upon these rods so as to flex the fingers against the force of the spring *l*, which assists in the return extension.

In each finger is an arrangement of rocking rods by which a positive motion is imparted in consonance with the motions of the slide in the wrist. The fork-holder is inserted in the palm of the hand, and consists of four elastic flaps which clasp the end of the fork handle. A certain amount of rotatory adjustment (by the other hand) is permitted to the wrist, so as to vary the presentation of the palm, in imitation of that performed by the ulna-radial motion.

Palmer gives a sinuous course to the flexor tendons of the fingers by means of sheaves, and opens the fingers by means of extensor tendons antagonizing the flexors by springs. The ball-and-socket wrist-joint is held together by cords.

In his forearm, the flexor and extensor tendons are similarly actuated, but the closing of the hand is effected by means of a strap to which the flexor tendons are attached. The strap is clamped in the flexed position when required.

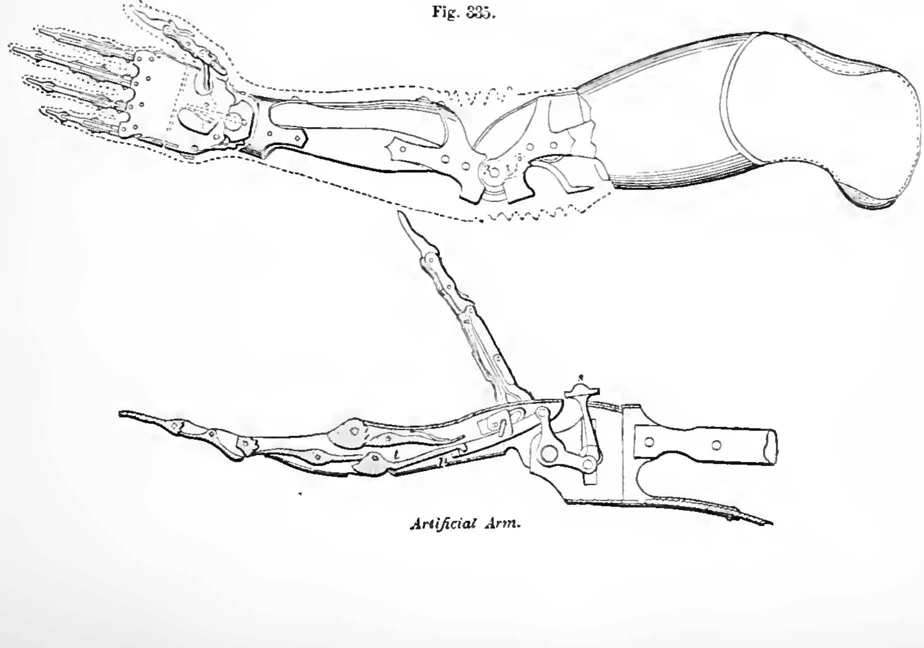
Fig. 334.



Artificial Arm.

In Fig. 334 the fore and upper arm are hinged

Fig. 335.



Artificial Arm.

together, and provided internally with a lock-plate to retain them in a flexed position when required. To release the forearm a projecting catch is touched, which disengages the catch-plate, allowing the arm to swing. To fasten the forearm flexed, it is swung forward, when the lock catches of itself. The hand is secured on the forearm, and it and the fingers are rigid in a grasping position. The thumb shown in the smaller figure has a constantly acting internal spring, and retains articles placed in the grasp between the thumb and fingers. The hand may be detached, and a hook substituted therefor.

In Fig. 335 each articulation has a ratchet and spring pawl attachment whereby any flexion imparted is maintained until freed by a means which trips the triggers. The forearm at the elbow-joint has a ratchet, and a spring pawl is pivoted on the upper-arm piece. By pressing on the back of the pawl, the latter is disengaged and the forearm freed. By the other means cited, the thumb and fingers are flexed so as to grasp an object, and are maintained in their bent positions by their respective ratchets and pawls. By pulling out the button *s*, the cross-bar *p* is driven up and overturns the rods *t*, which will bring the fingers back to their distended position.

In the above, the *hand* has necessarily been considered in connection with the arm which actuates it, and in some cases owing to its being associated with an arm of peculiar construction, although its own operative parts had no necessary connection with that specific arm. For some other varieties of hand structure, see HAND, ARTIFICIAL.

Ar′ma-ment. A term expressing collectively all the cannon and small-arms, with their equipments, belonging to a ship or fortification; frequently applied, in a more restricted sense, to the artillery alone.

The armament of ships and forts has undergone a very great change within the past thirty years. About 1840 the 32-pounder gun was most usually employed both on shore and shipboard, 24-pounders forming no inconsiderable proportion of the armament of our forts. 8-inch and even 10-inch guns and howitzers were, however, mounted to some extent in the more important seaboard fortifications.

The armament of a line-of-battle ship mounting eighty-four guns consisted of twenty-two 32-pounders of 57 cwt. and ten 8-inch shell-guns of 63 cwt. on each of the two gun-decks, and twenty 32-pounders of lighter weight on the spar-deck; that of a 50-gun frigate was similar, omitting the battery of one gun-deck. In 1857 a 40-gun steam frigate was armed with twenty-four 9-inch guns on the main-deck and fourteen 8-inch and two 10-inch pivot-guns on the spar-deck; 11-inch pivot-guns were also introduced as a part of the armament of steam sloops and smaller vessels.

Rifled or breech-loading ordnance was practically unknown. The commencement of our late civil war brought with it the era of 15-inch smooth-bores weighing 50,000 pounds, and at or shortly after its close 20-inch guns, weighing more than 100,000 lbs. and carrying a ball of 1,060 lbs., had been cast. The former of these classes now forms the usual armament of our monitors. Rifled guns of calibers up to 10 inches (as the Parrott 300-pounder) were also introduced, and this size has been exceeded in Europe, 30-ton Armstrong breech-loaders, carrying a projectile of 600 lbs. weight, being now in use in the English navy, while North Germany and other continental nations are little, if any, behind in this respect. In the United States service great reliance has been placed on the "smashing" qualities of round projectiles of large caliber fired from smooth-bore guns when employed against iron-clad vessels, while the impression of European artillerists is that they are comparatively inefficient in competition with elongated projectiles discharged from rifled guns; these are, accordingly, the only kind now employed abroad on first-class war vessels, and appear to have almost, if not entirely, superseded smooth-bores, with the exception of mortars in the armament of fortifications.

Ar′ma-ture. A piece of soft iron applied to a loadstone or connecting the poles of a horseshoe magnet.

In certain forms of electro-magnetic instruments a magnetized armature is employed, which may either be a permanent magnet of steel or an electro-magnet. The armature must have a polarization the opposite of that of the magnet and by its use the recoil-spring may be suppressed.

Arm File. A name from the German. A *hand* file.

Ar′mil. An ancient astronomical instrument. When composed of one ring placed in the plane of the equator for determining the time of the equinoxes, it is called an *equinoctial* armil. When of two or more rings, one in the plane of the meridian for observing the solstices, it is called a *solstitial* armil. — WHEWELL.

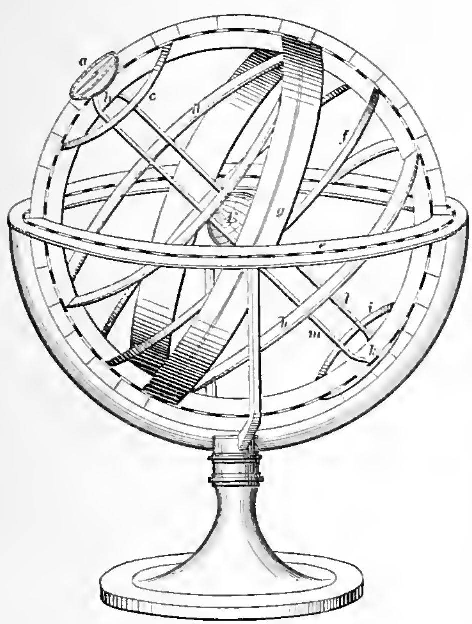
The *equinoctial armil* of the "Square Porch" of Alexandria is referred to by Hipparchus and Ptolemy. A *solstitial armil* is also described by Ptolemy (see Whewell, I. 201). These armils are divided into parts of sixths of degrees (10′). The reading was stated in parts of the circumference. Thus, Eratosthenes stated the interval between the tropics to be $\frac{11}{83}$ of the circumference. Ptolemy used a part of a circle, a *quadrant*.

It is supposed that Eratosthenes suggested to Ptolemy Euergetes the construction of the large *armillæ*, or fixed circular instruments which were long in use in Alexandria. Eratosthenes of Cyrene was born B. C. 276, and left Athens at the invitation of P. Euergetes, who placed him over the library in Alexandria, where he remained till the time of P. Epiphanes about B. C. 196. He is celebrated for his attempt to measure the magnitude of the earth. He discovered the obliquity of the ecliptic, which he made to be 23° 51′ 20″. He ascertained that Syene in Upper Egypt (lat. 24° 10′ N.) was in the tropic, a vertical gnomon casting no shadow at noon on the day of the summer solstice, and thence determined its latitude to be equal to the obliquity of the ecliptic. Observations at Alexandria determined the zenith of that place to be distant $\frac{1}{50}$ part of the circumference of the earth from Syene, the arc of the meridian between the two places being equal to 7° 12′, which was measured by the Ptolemies and found to be 500 stadia. This gives roughly 250,000 stadia for the circumference of the earth. The Olympic stadium was 202¼ yards. See ODOMETER.

Ar′mil-la-ry Sphere. An instrument to illustrate the motions of the heavenly bodies. It was invented by Eratosthenes about B. C. 255, and was employed till the time of Tycho Brahe, A. D. 1582. It was ordinarily made of brass, and disposed in such a manner that the greater and lesser circles of the sphere are seen in their natural position and motion. It was perhaps the principal agent in astronomical observations in the museum of Alexandria, which was founded by Ptolemy Soter, B. C. 298, and was plundered by Cyril A. D. 415, who probably thought the sphere was some heathenish machine for invoking the infernal gods.

It was used by Aristarchus, who first took the heliocentric view of the solar system; by Archimedes, the grand master of mechanics, contemporaneously with the building of the great wall of China; by Eratosthenes, the originator of astronomical geography; by Hipparchus, the father of mathematical astronomy; and by Ptolemy, the astronomer, A. D. 150, whose system was accepted down to the time of Tycho Brahe, A. D. 1582, and until Copernicus, Kepler, and Galileo revived the true views of Aristarchus, the heliocentric theory promulgated nearly two thousand years before.

Fig. 336.



Armillary Sphere

E. The earth.
a. Hour circle.
b. North pole of the heavens.
c. Arctic circle.
d. Tropic of Cancer.
e. Celestial horizon.
f. Celestial equator.
g. Ecliptic.
h. Tropic of Capricorn.
i. Antarctic circle.
k. South pole of the heavens.
l. Solstitial colure (summer).
m. Solstitial colure (winter).

The armillary sphere consists of a frame with a horizon on which are represented the 360°, the region of the heavens, the calendar, and the hight of the sun for every day in the year. Two notches in the horizontal circle, and corresponding to its north and south points, receive the fixed meridian, whose plane is perpendicular to, and center coincident with, that of the horizontal circle. Within this meridian the other circles, as well as the small terrestrial globe, may all be rotated together on the common axis of the heavens and earth. The meridian can be moved in its notches, still retaining its vertical plane, and in this manner the general axis may be placed at various angular distances with the horizon. The center of the small terrestrial globe is coincident with that of the general armillary sphere. The hour circle is fastened to the north pole of the fixed meridian, and has a movable index, which when fastened revolves with the axis. It is still used in demonstrating astronomical problems.

The armillary sphere of the Hindu astronomers is described in the Sanscrit treatise "Sûrya-siddhânta," translated by Rev. E. Burgess, and published in the Journal of the American Oriental Society, Vol. VI. pp. 141–498, New Haven, 1860. The instrument was illustrative of the positions and motions of the heavenly bodies, rather than for astronomical observations: in this respect differing from the Greek, Arab, and early European instruments.

Arm'ing. (*Nautical.*) A plug of tallow in the hollow at the bottom of a sounding lead, to bring up sand, minute shells, infusoriæ, etc., from the bottom.

Arm'ing-press. (*Bookbinding.*) A screw press having a platen heated by gas-jets, and serving to fix the gold-leaf upon the book-covers upon which it is impressed. See BLOCKING-PRESS.

Arm'let. A clasp or loop for confining the sleeve to the upper portion of the arm. Used to loop up the short sleeve of children's dresses.

A protecting sleeve of leather or metal, worn on the forearm, and used as a shield for the arm or as a covering for that portion of the coat-sleeve.

Ar'mo-rer's Gage. For verifying the dimensions of the various parts of small-arms are templets of various sizes and shapes, rings, and cylindrical or conical gages for interior dimensions. 200 are embraced in a complete set for the various arms made at the Government armory, of which about 78 are used for the rifle-musket alone.

Of these, the *caliber gage* measures the diameter of the bore.

The *dimension gages* show the length of the barrel and its diameter at various distances, the value in inches and parts being measured by the *caliper gage.*

Other gages measure the proper dimensions of the breech-screw and its thread, and those of the counterbore of the barrel which receives it; others, again, the form, dimensions, and position of the sights.

A separate gage is required for the lock-plate, and for each separate part of which the lock is composed; as the *mainspring gage, sear gage, bridle gage, tumbler gage, hammer gage,* etc.; also gages for the various dimensions of the stock, of the bayonet, and of each of the appendages which accompany the gun.

The number of 200, above given, might be swelled to several thousand, by including those required for inspecting the various carbines and pistols made by different parties for the United States government; all which were made so that the parts of the same kind might be interchanged.

Ar'mor, Per'son-al. Defensive clothing or covering for the body in battle.

Scale and chain armor were common among the old Egyptians (time of Rameses III.) and Assyrians, also among the Persians and Romans. Dr. Abbott's collection in New York contains the iron helmet and scale armor of Sheshonk, or Shishak, the king of Egypt who overthrew Rehoboam, seven years after the death of Solomon. The scales are the shape of the Egyptian shield round end downward, and some of them are marked with the cartouche of the king.

The Sarmatians wore scale armor of pieces of horn or horse-hoofs fastened to a linen doublet.

Goliath was armed with a coat of mail (1 Samuel xvii). It is frequently spoken of by Homer. Demetrius, son of Antigonus, had a coat of mail made of Cyprian adamant (perhaps steel). Cyprus was famous for its armor. The ancient Scythians had armor composed of horse's hoofs curiously strung and jointed together. Hengist the Saxon had scale armor A. D. 449, and King John of England possessed a hauberk of rings set edgewise, 1200. The cavalry of Henry III. had coats of mail. Henry VII. had a steel cuirass, 1500. Since the introduction of fire-arms the use of armor has been gradually discontinued, and it is now confined to the heavy cavalry or cuirassiers of European armies. As worn at present, it generally consists of a helmet of brass strengthened with steel, and a cuirass composed of a front piece, or breast-plate, and a back iece strongly laced or buckled together. The suc ess of the French cuirassiers in the famous cavalry combat at Eckmuhl, 1809, was in a large degree owing to their wearing complete cuirasses, while he Austrians were only provided with breast-plates.

For illustrations and descriptions see Frost's Pictorial Histories, and the Iconographic Encyclopædia.

Of ancient armor some remarkable examples are to be found in the tribolites of the Silurian age, "a family in whose nicely jointed shells the armorer of the Middle Ages might have found almost all the contrivances of his craft anticipated, with not a few, besides, which he had failed to discover. They were covered over, back and head, with the most exquisitely constructed plate-armor; but as their abdomens seem to have been soft and defenceless, they had the ability of coiling themselves round on the approach of danger, plate moving on plate with the nicest adjustment, till the rim of the armed tail rested on that of the armed head, and the creature presented the appearance of a ball defended at every point. In some genera, as in Calymene, the tail consisted of jointed segments till its termination; in others, as in Illænus, there was a great caudal shield, that in size and form corresponded to the shield which covered the head; the segments of Calymene, from the flexibility of their joints, fitted close to the cerebral rim; while the same effect was produced in the inflexible shields, caudal and cephalic, of Illænus, by their exact correspondence, and the flexibility of the connecting rings, which enabled them to fit together like two equal-sized cymbals brought into contact at every point by the hand." — HUGH MILLER.

Ar′mor-plat′ed Ves′sel. A vessel whose exposed portions are protected by iron plates. The plating reaches a certain distance below the water-line when in fighting trim. See ARMOR-PLATING.

Ar′mor-plates, Ham′mer-ing and Roll′ing. Armor-plates may be either hammered or rolled. When it is desired that the armor shall be of one thickness of stout plate of from four to six inches, hammered iron seems to be preferable on account of the increased tenacity conferred upon the plate by the closer interlacing and condensation by this process. Owing principally, however, to the greater rapidity with which rolled plates can be manufactured, and the facility with which they can be laid together and bolted so as to constitute armor of any required thickness, and the ease with which a damaged plate can be replaced, the rolling process has been more generally resorted to in this country. Hammered-iron plates are made from "blooms," which may be procured from the forge, or preferably made at the works where the plate is forged. Any description of good scrap wrought-iron will answer for this purpose, as it is soon converted into one homogeneous mass under the steam-hammer. The scraps are piled into "fagots" of convenient size, and placed in the furnace. After reaching a welding heat, they are taken from the furnace by tongs suspended from a chain, and laid upon an anvil under the steam-hammer. By the first blow of the hammer an iron rod, one end of which is held by a workman, is welded into the fagot for the purpose of turning and manipulating it while being hammered. A very few minutes' pounding by the heavy hammer suffices to bring the mass into the bloom shape, — a bar of homogeneous iron some four or five feet in length and six inches thick; when sufficiently hammered, the handle is cut off, and the bloom is ready to take its place in combination with others in the formation of a plate. In this operation a long and stout bar of round iron, flattened at one end, is used for supporting the pile, which is composed of several layers of blooms laid in tiers one upon the other transversely; these are placed in the furnace upon the flattened end of the above bar, which is suspended near its mid length from a crane, and is clasped by tongs or handles to enable the workmen to turn and move the mass as desired; when sufficiently heated for welding, which requires several hours, the pile is drawn from the furnace, swung round and placed upon the anvil by the crane assisted by the handles held by the workmen, and subjected to the action of the hammer.

When the blooms are thoroughly welded and the pile drawn down to about the required width and thickness of the plate, another pile of blooms is added, welded on to its end, and the operation thus continued until the desired length is attained. When this operation is completed, the plate is again heated and passed under the hammer, water being thrown upon it as it is advanced forward, which assists in removing scale and cleaning and smoothing the plate; these are then drilled to receiving the bolts for fastening them into position on the ship, and afterward bent to the required curve.

The operation of rolling the larger description of armor-plates involves a number of appliances not usual in ordinary rolling-mills. The mass of iron, being heated in the furnace, is drawn thence by chains attached to the steam-rollers and received by a wrought-iron car. The forceps being detached and the chains clear from the rolls, the car is advanced to the head of the incline, which it then traverses by its own weight, and lands the edge of the plate into the grip of the rotating rolls. The plate is received on the other side of the rolls by another wrought-iron truck. The rollers being set nearer to each other by about an inch, their motion is reversed, the plate landed into their grip, and carried through to the other side. This is repeated again and again, setting the rollers closer between each operation, until the required dimensions are obtained. Sand is thrown on the plate from time to time, and water, which detaches the scale of oxide. This is removed by scrapers. The plate, being then laid upon the floor, is subjected to the action of 15-ton rollers, which levels and smooths the surface. The dimensions here stated refer to the apparatus used in rolling a 15-inch armor-plate in England.

Ar′mor-plat′ing. The application of iron for this purpose is of very modern origin. Cast-iron plates had been proposed long before as a revetment or facing for fortifications; but this material was soon found unsuitable, on account of its brittleness, and consequent liability to be fractured by shot.

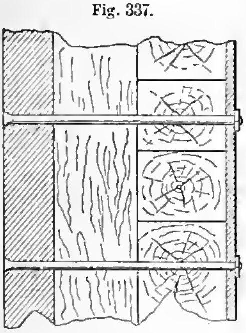
Iron armor was suggested in the United States in 1812, in France in 1821, and was experimented upon in England in 1827 at the suggestion of General Ford, who proposed to protect fortifications by wrought-iron bars.

Gregg's United States patent, March, 1814, was an iron-clad bomb-proof steam vessel, and will be noticed presently.

The first practical use of wrought-iron plates as a defense for the sides of vessels appears to have been made by the French during the Crimean war. These vessels, — floating batteries, as they were termed, — though they seem to have had sufficient sea-going qualities to enable them to navigate the Mediterranean and Black Sea, were of light draft and exposed very little surface above water; they rendered very efficient service, especially at the bombardment of Kinburn, in 1855, and their success probably led to the adoption by the French government of armor-plating on a much more extended scale; "La Gloire," launched in 1859 or 1860, having been the first large iron-plated ship afloat. Her armor consisted of 4½-inch rolled-iron plates, supported by a backing of wood some three feet in thickness.

England, with the determination not to be behind her Continental neighbor, commenced the construction of iron-clads immediately afterward. The most noted of those first built in England was the "Warrior," whose armor was of 4½-inch plates, backed by and bolted on to 18 inches of teak wood; the plating, however, merely covered the midship portion of the vessel for some 200 feet, leaving a large space both at the bow and stern of the vessel unprotected.

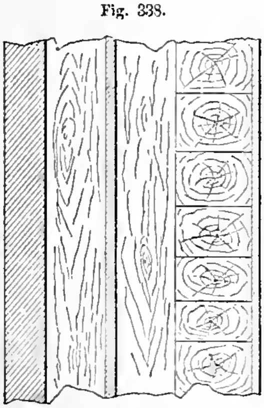
Fig. 337.



Section "Warrior's" Armor.

Another class of iron-clads in the British Navy, represented by the "Royal Oak," were wooden ships of the line, not originally intended for carrying armor, but which have been covered with 4½-inch iron plates bolted on to their wooden hull. In one respect they have the advantage of the "Warrior," their sides being completely mailed from stem to stern, as are those of "La Gloire." The "Minotaur," and others of her class, were originally constructed to receive plating. They are of very large size, about 6,650 tons, and are also completely protected, the plating extending throughout their entire length, and to a depth of several feet below the water-line; it is similar to that of the "Warrior," from 4½ to 5½ inches thick, having, however, a wooden backing of but 9 inches, which is said to be, and no doubt is, too thin to insure the great rigidity required.

Fig. 338.

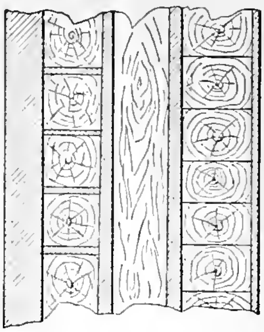


"Hercules."

The armor adopted for the "Hercules," which was another typical form of English iron-plating, consists of an outer plating of rolled iron 8 inches thick, inside of which is 12 inches of wood, 1½ inches of iron, and 26 inches of wood, in the order named, and an interior iron lining.

Mr. Chalmers's system, for which he claims very superior efficiency and strength, is represented in the annexed figure; it is composed of alternate layers of iron and wood, the outer iron plating being strengthened by horizontal plates interposed between the beams of the outer layer of wood.

Fig. 339.



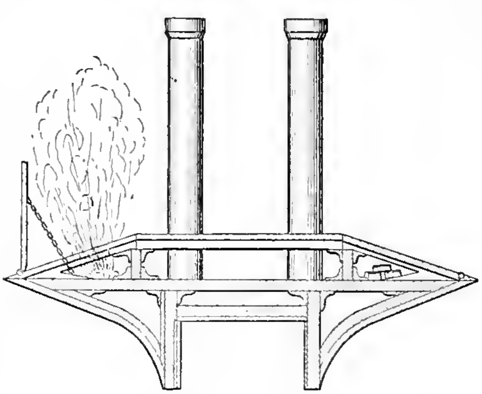
Chalmers's.

This armor has been severely tested in England, and is reported to have given very good results.

It is understood that the "Palisser" bolt, in which the shank is reduced to the same diameter as that of the smallest part of the thread, is now used for fastening armor-plates in the British navy.

The subject received very early attention in this country, and as early as March, 1814, a "Ball-proof Vessel" was patented by Thomas Gregg, of Fayette Co., Pennsylvania. The design embraced a flat upper deck, from which the sides and ends sloped outwardly to the water-line, where the upper part of the vessel was very broad, overhanging the submerged portion and protecting the rudder and means of propulsion. The gun-deck was nearly level with the water-line, and ports were cut in the sloping sides. The external appearance of this

Fig. 340.



Gregg's Ball-proof Vessel.

floating battery seems to have been very similar to that of the confederate "Virginia," formerly the "Merrimac," or some of our Western iron-clads. Copper or iron was proposed as a covering for the exposed portion. It does not appear that a vessel was ever actually constructed on Gregg's plan, but the invention is interesting as embodying some of the features which were afterwards adopted by both North and South during the emergencies of our late war, and as showing that only some seven years after the first successful application of steam as a motive-power for vessels, it was proposed to employ it as a means of propulsion for iron-clad floating batteries.

In 1842 the late R. L. Stevens commenced at New York the construction of an iron-clad war-vessel, under an agreement with the government, which seems to have never been completed.

This vessel, it is understood, was intended for speed, her lines being very sharp. Her dimensions have been stated as follows: —

Extreme length . .	420 feet.	
Beam	52 "	
Depth from fighting-deck	28 "	
Draft with coal and stores	20 "	6 inches.
Fighting-draft . . .	22 "	6 "

She is provided with compartments into which water is admitted upon going into action, so as to sink her two feet deeper in the water, thus leaving a lesser exposed surface. These compartments may be rapidly emptied by steam-pumps. The side armor extends outside of the hull from stem to stern to a distance of four feet below the line of fighting draft, and is plated with $3\frac{1}{2}$-inch iron. The armor of the casemate, which is sloping and has a shot-proof deck, is composed of $6\frac{3}{4}$-inch plating backed by 14 inches of locust timber, in which are imbedded 6-inch wrought-iron beams at distances of two feet from each other. The upper deck is of $1\frac{1}{2}$-inch iron plates resting on 6-inch wrought-iron girders, filled in with timber and lined with $\frac{1}{2}$-inch iron plate. The guns are to be used *en barbette* upon the top of the casemate, and are to be loaded from below, by machinery, through holes in the deck; they are pointed from within, and by means of a graduated index within the casemate each gun may be brought to bear simultaneously on the same object.

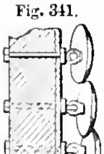
Captain Ericsson designed the Monitor class of vessels in 1854, though the idea seems to have lain dormant till the times were propitious. The "Monitor" attacked the "Merrimac" March 9, 1862, and, on the 11th of May following, the latter committed suicide. The revolving turret was invented by T. R. Timby, and was patented by him in 1862. Captain Coles introduced a modification into the British navy, and was lost when the ill-fated double-turreted "Captain" foundered off Cape Finisterre, July, 1870. The "Captain" had two large turrets placed amidships, in each of which were mounted two 25-ton rifled guns, throwing solid elongated projectiles of 600 pounds, or shells of proportionate weight. In the forecastle and poop were two or three guns of smaller caliber. The thickness of her plating varied from six to ten inches. She was full-rigged, had two independent screws, engines of extraordinary power, steering apparatus of curious perfection, and a picked crew of 500 men.

The original "Monitor" foundered off Cape Hatteras with all on board.

There are now 54 iron-clad monitors in the United States service. The plating of the deck and overhanging portion of the hull usually consists of five 1-inch iron plates, backed by and bolted on to a wooden backing some three or more feet in thickness. The revolving turret is composed of eleven similar plates, firmly bolted together, and so arranged as to break joints.

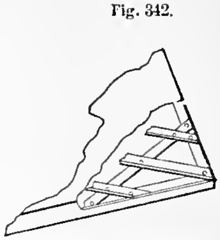
As might naturally be supposed, the late war was fertile in the production of devices for the protection of war vessels, displaying more or less ingenuity and adaptability to that object. In the first and most numerous class of these, solidity and strength, derived from the arrangement of the plates and the manner of fastening and backing them, were principally taken into consideration; while in the second it was proposed to deaden the force of a ball striking the armor by giving the latter a considerable degree of elasticity or resiliency, allowing it to yield and afterward return to its normal position. Some examples of each of these classes will be given, as illustrating the different modes proposed in order to arrive at the same result. These are arranged according to the dates of the patents. Among the first was that of F. COMTESSE, April 22, 1861, who proposed to employ convex rounded shields, partially overlapping each other, attached to the sides of the vessel by loops and eyebolts, for the purpose of causing the ball to glance off upon striking.

Fig. 341.



Comtesse's Armor.

Fig. 342.

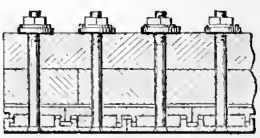


WARDEN'S patent, February 25, 1862, embraces a wrought-iron lattice framing, in and upon which an iron body is cast, so that, the latter being fractured, the pieces would still maintain their places, and protect, or partially so, the side of the ship.

Warden's Armor-Plating.

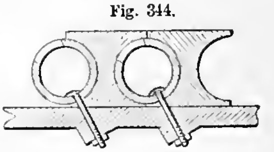
JONES'S Defensive Armor for Land and Water Batteries, April 15, 1862. In this invention the armor-plates have edge and intermediate flanges, and are placed in two tiers having intermediate cushions between them; they rest against foundation-cushions, the whole being bolted together and to the casemate or side of the vessel by bolts, which are provided with elastic washer-cushions.

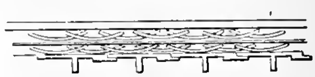
Fig. 343.



Jones's Armor-Plating.

Fig. 344.

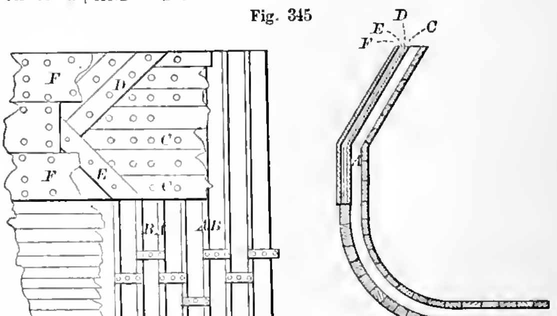




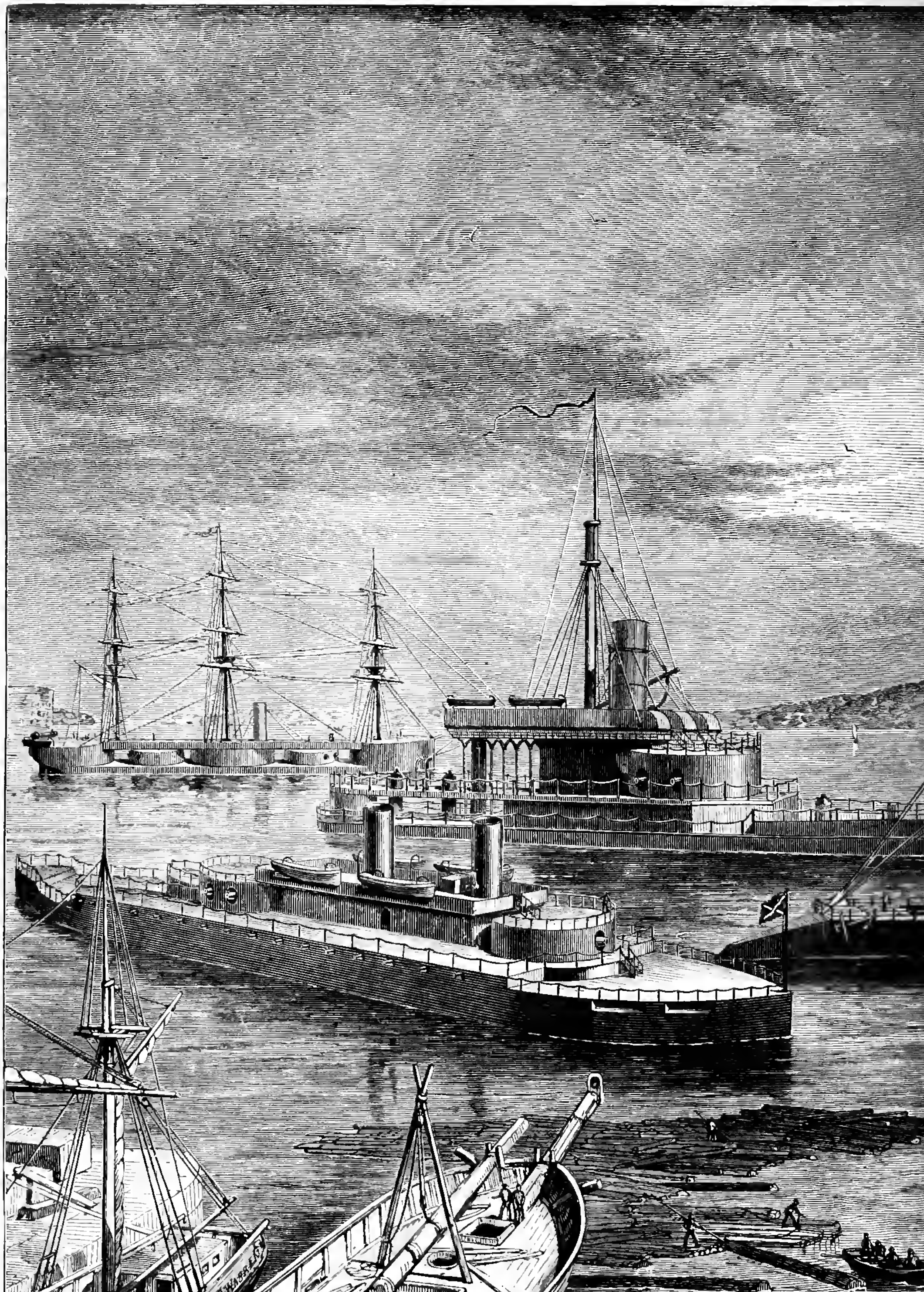
Callender and Northrup's Armor.

CALLENDER AND NORTH-

Fig. 345



Ballard's Armor.

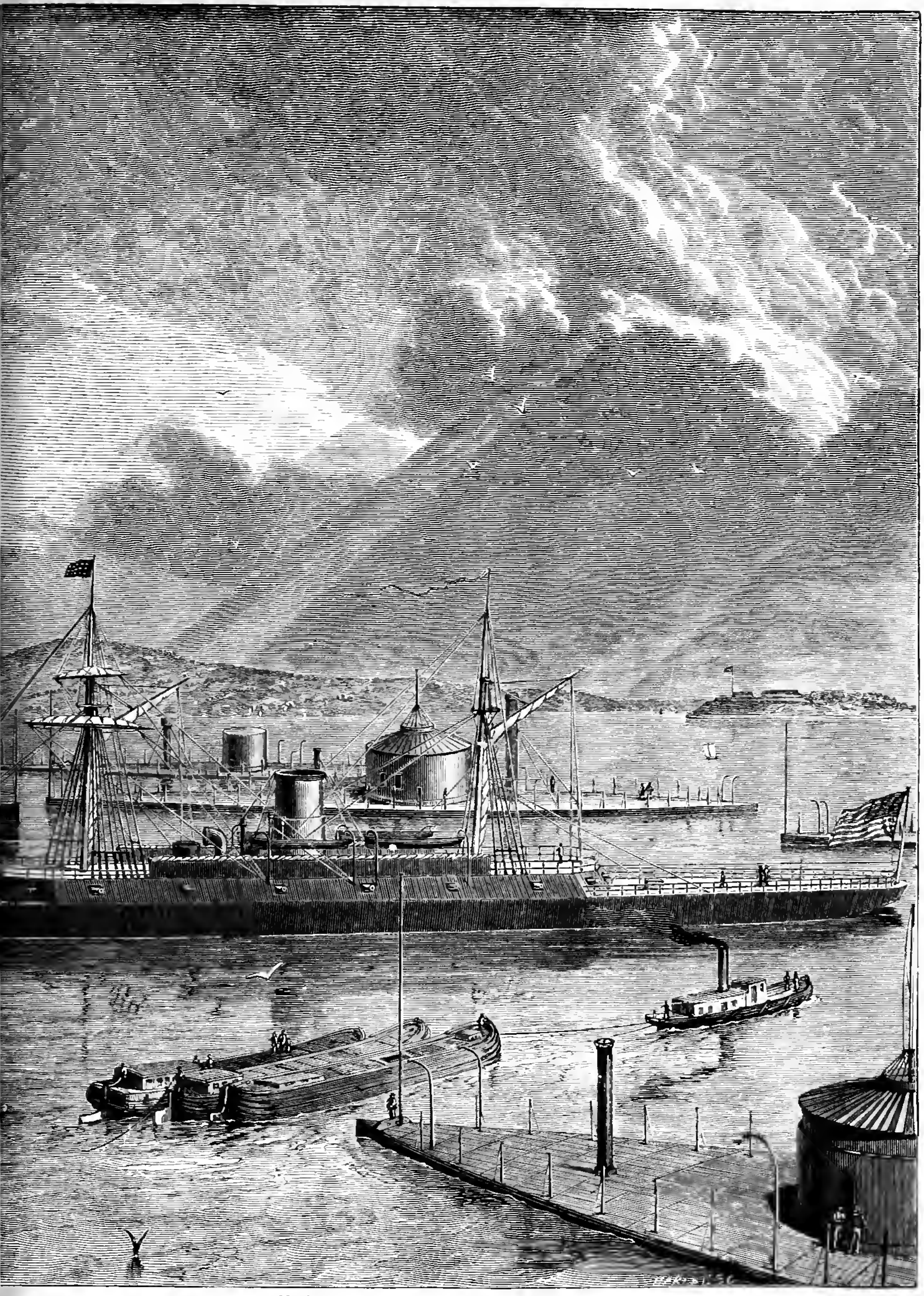


Captain. Thunderer. Glatton.

ARMOR PL

(English c

PLATE IV



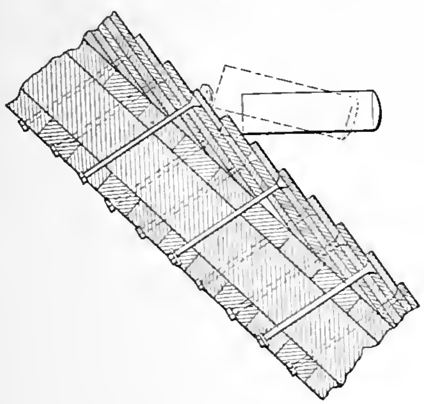
D VESSELS
American.)

See page 130.

RUP's Defensive Armor, May 27, 1862, is composed of ribbed plates which are fastened to interior concave stringers by bolts passing through the stringers and into metallic tubes between them; each plate has a lap at its edge to fit the corresponding edge of the next plate, to which it is riveted. The nuts are on the outside.

BALLARD's armor, June 24, 1862, consists of a series of inner iron ribs A A, with interposed wooden frames B B, longitudinal covering bars or plates C C, diagonal bars or plates D E, and outer covering plates F F.

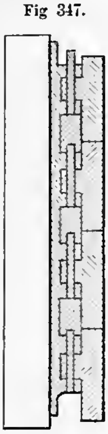
Fig. 346.



Hotchkiss's Armor.

HOTCHKISS's "Metallic Defensive Armor" for vessels and fortifications is formed by a series of plates, in which the lower ones overlap the higher, so that when any one of them is struck by a projectile, the projecting edge may become detached, glancing the shot on to the next plate, by which it is further deflected and prevented from penetrating the armor. The cut represents the action of a cylindrical bolt whose edge has impinged upon one of the lapping plates; the dotted lines show the bolt in a subsequent position, in contact with the piece of armor-plate which it has removed, and glancing upon the successive plates.

Fig 347.



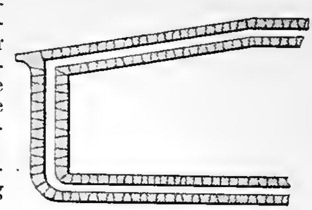
Wood's Armor.

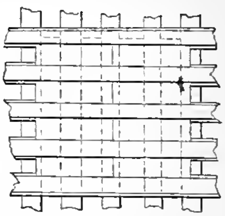
WOOD's armor, September 23, 1862, comprises sets of inner and outer plates, the former secured to the vessel by bolts whose heads are covered by the latter, each plate in the one set having a rib which fits between ribs on a plate of the other set, the two plates being connected together by pins passing vertically through the ribs. Longitudinal spaces are left at intervals between the inner and outer plates for the introduction of wood or an equivalent material.

BABBITT's armor-plating, January 13, 1863, for ships or batteries, is composed of wedge-shaped bars laid crosswise to two other sets of bars, the whole being dovetailed together and filled in with cast metal.

MONTGOMERY's armor, February 10, 1863, depends much upon its resiliency to resist the impact of projectiles. The outer plates are notched into each other, and fastened together and to a corrugated plate by a rod. This corrugated plate rests against the outer casing, between which and the inner casing are cylinders of vulcanized rubber placed perpendicularly to the casings, the whole being bolted together.

Fig. 348.



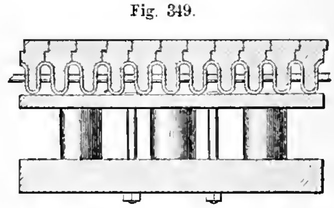


Babbitt's Armor-Plating.

BRADY's method of "Affixing defensive Armor-Plates," March 3, 1863, is by attaching them edgewise to the object to be protected, and securing them by means of bolts, whose ends pass into cavities in the inner edges of the plates, and are made fast by being enlarged therein, or by being intersected by transverse apertures through which pins or keys may be passed.

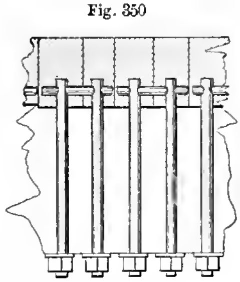
In WAPPICH's system, March 3, 1863, the outer plates have projections passing through the hull and interior plating, where they are keyed; each outer plate has also projections or lugs k, entering the casing d to a certain distance, and receiving the bolts l, which are keyed to the interior plate: it has also notched flanges, or bent ends, passing into the casing; these are employed to bind the ends of the plates together, and increase the stability of the armor. The outer adjoining edges of the plates are grooved for the insertion of india-rubber strips, as at m, for making the joints water-tight. The port-holes are strengthened by iron

Fig. 349.



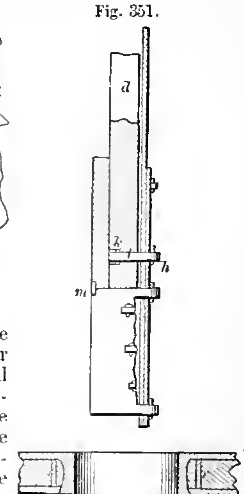
Montgomery's Armor.

Fig. 350



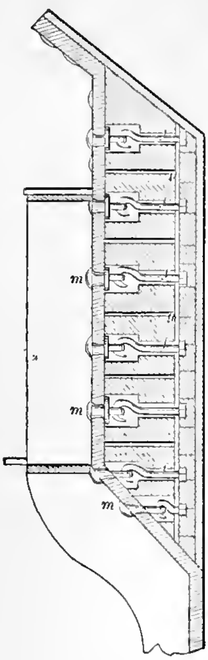
Brady's Armor-Plating.

Fig. 351.



Wappich's Armor.

Fig. 352.



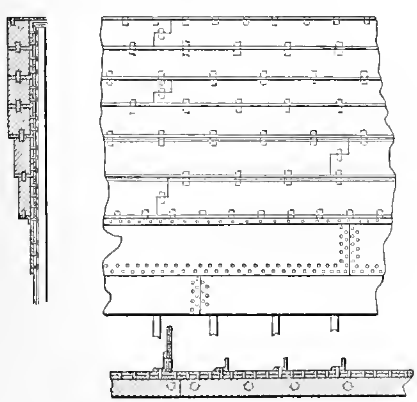
Tufts's Armor.

plates *o*, extending around their edges, and also by an encircling frame or ring *r*, between the inner and outer plating. Each plate may be so arranged as to be pushed out, upon removing the keys *h*, and others substituted. This system of plating is designed for circular turrets, as well as for plain or slightly curved surfaces.

Tufts's Construction and Defence of War Vessels, March 24, 1863. The sides of the vessel are recessed by bending inward the frame and the plating thereon, thus maintaining the symmetry of the outward form. Recesses are made in the sides, in which the fixtures *m m* are secured, having eyes into which screw-bolts *f f* are hooked. These screw-bolts pass through the casing to the outside of the straps *g*, where they screw into nuts.

Eads's Defensive Armor for Marine and other Batteries, July 14, 1863, consists of inner angle-irons, the flanges of which pass between the horizontal layers of armor-plates. Dowel-pins, inserted in holes in the flanges, enter the

Fig. 353.



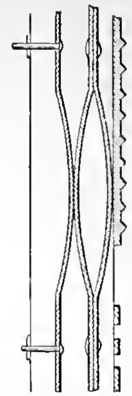
Eads's Armor.

layers of armor-plating above and below them, thus binding the whole together. The plates are so arranged as to break joints.

Twining's "Means of Checking and Resisting Missiles," July 28, 1863, embraces an arrangement of successive plates or layers with successive intervals between, and with lugs, angle-irons, or projections, when necessary; the mode of constructing the successive layers and spaces between is by bending forward and back a single plate, or several plates in layers, from the outside to the inside, the plates being bolted together occasionally at their contacting portions.

The arrangement of Dimpfel's armor, Aug. 4,

Fig. 354.



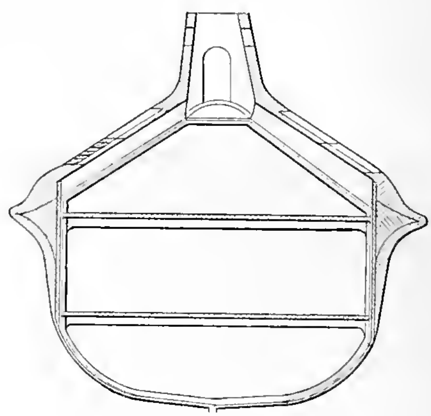
Twining's Armor.

Fig. 355.

Dimpfel's Armor.

1863, will be readily understood by reference to the cut. The ends of one series of plates are let into grooves of a transverse set of T-iron plates, which

Fig. 356.

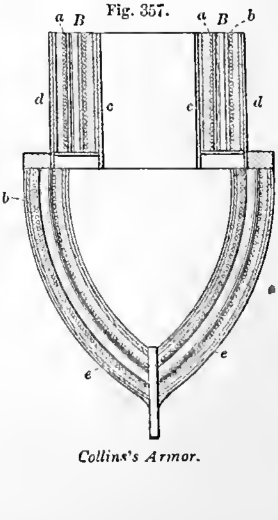


Caudwell's Armor.

are bolted to the backing. It is intended for application to either land or marine batteries.

Caudwell's Construction of Ships of War. This invention was patented in England April 10, 1863; in the United States, January 19, 1864. The design embraces a corrugated iron-plated roof with port-holes in the corrugations; the port-shutters are composed of a number of separate plates of iron or steel one above another, and fit into grooves in the edges of the armor-plates. Around the vessel, just above the water-line, is a

Fig. 357.



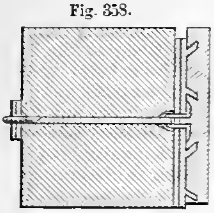
Collins's Armor.

projecting lip, to which india-rubber, or other similar material, may be attached.

Collins's Armor for Ships and Fortifications, April 19, 1864, consists of a framing of wrought-iron tubular ribs *B B*, with external coils of steel wire *a a*, and surrounding casings of india-rubber *b b*. Corrugated plates *c c* confine the tubes together, and serve as attachments for the inner and outer skins *c d*.

Carpenter's Ship's Armor, May 23, 1865. In this device the middle plates, of steel or wrought-iron, have dovetailed projections fitting into corresponding grooves in their outer facings, which, as well as the inner backing-plates, are of chilled cast-iron. Staples pass through the inner and middle plates and into the outer one; the loop of each staple is let into a recess in the side of the vessel, and is caught by a bolt which passes through the side and is secured in the interior.

Fig. 358.



Carpenter's Armor.

The following statement from the "London Times" contains the dimensions of a number of English iron-clads, with the thickness of their armor, etc.

Names.	Tonnage.	Horse-Power.	Length.	Beam.	Protected Guns designed for.	Thickness of Armor.	Thickness of Backing.
Achilles	6,221	1,250	380	58	26	4½	18
Black Prince	6,109	1,850	380	58	26	4½	18
Warrior	6,109	1,250	380	58	26	4½	18
Agincourt	6,621	1,350	400	59	36	5½	10
Minotaur	6,621	1,350	400	59	36	5½	10
Northumberland	6,621	1,350	400	59	36	5½	10
Hector	4,089	800	280	56	32	4½	18
Valiant	4,063	800	280	56	32	4½	18
Defence	3,720	600	280	54	16	4½	18
Resistance	3,710	600	280	54	16	4½	18
Caledonia	4,125	1,000	273	59	32	4½	Wood ship, side 29½ in.
Ocean	4,047	1,000	273	58	32	4½	" 29½ "
Prince Consort	4,045	1,000	273	58	32	4½	" 29½ "
Royal Alfred	4,068	800	273	58	32	4½, 6	" 29½ "
Royal Oak	4,056	800	273	58	32	4½	" 29½ "
Lord Clyde	4,067	1,000	280	59	34	4½, 5½, 6	" 31½ "
Lord Warden	4,067	1,000	280	59	34	4½, 5½, 6	" 31½ "
Zealous	3,716	800	252	59	16	4½	" 30½ "
Bellerophon	4,246	1,000	300	56	12	6	10
Pallas	2,372	600	225	50	5	4½	Wood ship, side 22 in.
Favorite	2,094	400	225	47	8	4½	" 26 "
Research	1,253	200	195	38	4	4½	" 19 "
Enterprise	993	160	190	36	4	4	" 19½ "
Viper	737	1 0	160	32	2	4½	10
Vixen	754	160	160	32	2	4½	10
Water Witch	777	167	162	32	6	4½	10
Prince Albert	2,529	500	240	48	6	4½	18
Royal Sovereign	3,765	800	240	62	5	5½	Wood ship, side 36 in.
Scorpion	1,857	350	220	42	4	3, 4½	9
Wivern	1,857	350	220	42	4	3, 4½	9

"The British naval authorities have lately tried a practical, if expensive, experiment by anchoring their biggest and newest iron-clad, the "Glatton," in Portland harbor, and detailing another ship to make her turret a target for 600-pound projectiles. The Admiralty is probably satisfied with the trial, for although the turret was pretty badly damaged it was not disabled. The experiments will be continued in the hope of finding a system of iron-plating which will resist any possible projectile, and a projectile which will knock to pieces any possible system of iron-plating." — *English Paper.*

This is of a piece with the old problem, which modern slang would call a conundrum: "When an irresistible body comes in contact with an immovable object, what is the result?"

Ar'mor, Sub-ma-rine'. Submarine armor may be held to include all the devices to be attached to the person by which one is enabled to descend in the water, be protected from extreme pressure while submerged, be furnished with vital air and with means for signaling the persons above and for assisting the ascent to the surface when necessary. These devices have been used in connection with the diving-bells, but the latter is not a necessary auxiliary. In the article on the diving-bell some instances of submarine armor are given, but only as incidentals.

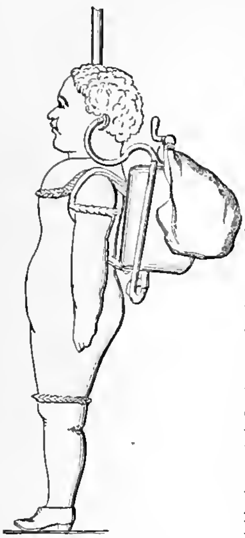
Submarine armor has not as clear claims to antiquity as the diving-bell, if we accept the accounts of Aristotle and Jerome. The earliest distinct account of the diving-bell in Europe is probably that of John Taisnier, quoted in Schott's *Technica Curiosa*, Nuremberg, 1664, and giving a history of the descent of two Greeks in a diving-bell, "in a very large kettle, suspended by rope, mouth downward"; which was in 1538, at Toledo, in Spain, and in the presence of the Emperor Charles V.

Beckman cites a print in editions of Vegetius on War, dated in 1511 and 1532, in which the diver is represented in a cap, from which rises a long leather pipe, terminating in an opening which floats above the surface of the water.

Dr. Halley, about 1717, made a number of improvements in the diving-bell, and among them a leather cap for the head of the diver, with windows in front for the eyes. This helmet was used by the diver when he left the bell, from which he received a supply of air through a flexible tube.

The essential parts of submarine armor consist of a helmet and a protection for the body. These are rendered necessary by the great pressure of the water even at moderate depths. For instance, at a depth little exceeding five fathoms (30 feet), this pressure amounts, including that of the superincumbent atmosphere, to about 29 pounds to the square inch, being an excess of some 14.7 pounds over that due to the atmosphere alone. For depths not exceeding 15 or 20 feet, armor for the body is not perhaps absolutely essential, though very desirable if the diver is required to remain a considerable time under water; this part of the apparatus may be constructed of leather, vulcanized rubber, or gutta percha, or of metal. The helmet is almost necessarily made of metal. It has glass windows to enable the diver to see, and two tubes, — one for supplying him with fresh atmospheric air from the surface, and the other for the eduction of the exhaled air. Weights are attached to the body of the diver or to the armor, if the latter is not sufficiently heavy of itself, to enable him to exert his full power under water; the human body being very nearly of the same specific gravity as that fluid. A line is attached to the apparatus, by which the operator is lowered to any given depth, or hauled to the surface by the assistants, and by which he can signal to them when necessary; for this purpose, however, another line is usually employed. Many different constructions have been proposed and executed. One of the best of the earlier forms was that of M. Klingert of Breslau, 1798, in which the helmet was made of strong tin, and the jacket and drawers of leather. Inhalation was made through a tube embraced by the lips of the diver, who, by the expansion of his chest at each inspiration, forced out of the helmet into another tube leading to the surface a quantity of previously exhaled air precisely equal to the fresh air taken into the lungs. In some of the older forms the helmet itself was made large enough to hold a quantity of air sufficient to supply the diver for a considerable length of time, differing little, in fact, from the diving-bell. The apparatus of Mr. Rowe, 1753, consisted essentially of a copper tube large enough to contain the body of the diver and a limited supply of air which could be renewed from time to time by a bellows or force-pump, and having windows and water-tight holes for the arms. These cases have, however, been completely superseded by the diving-bell, and it by the more modern forms of armor, some of which will be mentioned. See DIVING.

Fig. 359.

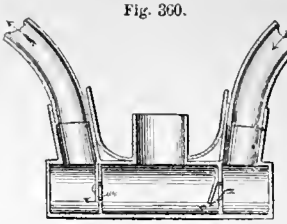


Diving Apparatus.

Fig. 359 shows a figure in a diving-dress, attached to which is a reservoir of compressed air sufficient to last the diver several hours. It is strapped to the dress, and communicates with the interior of the latter by a pipe which has a faucet. Expansible bags are attached to the shoulders, which are made buoyant by inflation from the compressed-air reservoir when required. The air-knapsack is weighted so as to enable the diver to sink to his work. The air-tube enters the mask at a point over the ear. The artist has made rather a close fit of the dress and mask, and the effect is rather too cherubic.

In Fig. 360 is shown a respirator designed to be attached to the helmet of the diver whereby air is supplied from a force-pump in the vessel which floats on the surface of the water. It has an induction and an eduction valve, which both open in the same direction, giving way respectively to the blast of fresh air and to the force of the exhaled breath. While the breath is being inspired by the diver the induction-valve is open to admit fresh air, and when expiration occurs, the induction-valve is closed, and the air passes out by the eduction-valve and the flexible tube, which latter reaches to the surface of the water.

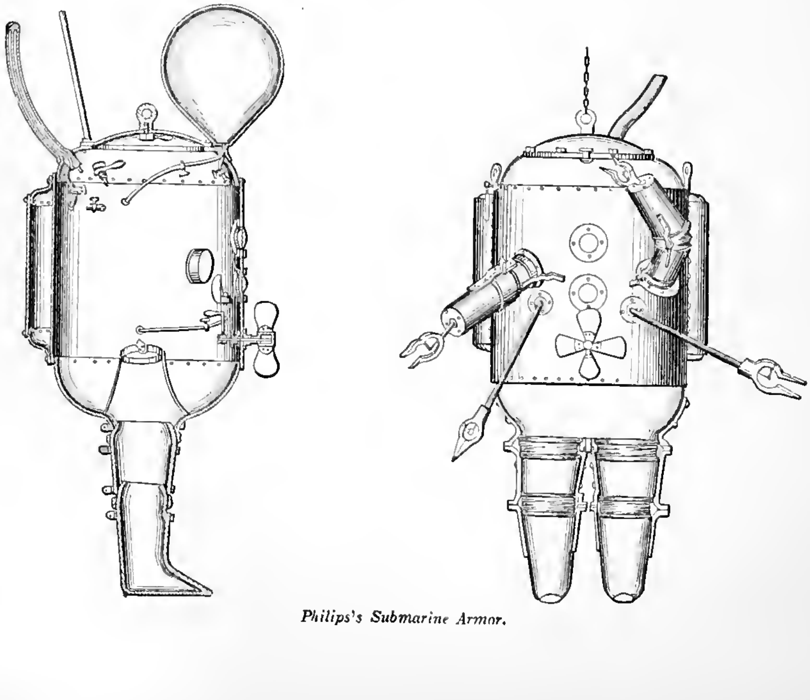
Fig. 360.



Hawkins's Mouthpiece for Diving Apparatus.

In Fig. 361 the diver is completely incased in the armor, which has flexible jointed limbs occupied by the legs and arms of the occupant, and enabling him to move from place to place and grasp the objects of his search or perform his other duty in the premises. The joints of the limb-casings have articulations corresponding to those of the person, and are flexed and extended by the natural motions of the diver. The prosthetic hands, which are attached to the ends of the tubular arm-casings, consist of tongs or nippers, operated by rods, which are moved by the natural hands inside. The body and head of the person occupy the chamber, which is large enough to permit free motion, and the chamber is attached to the person by bands, and a girdle about the loins. An exterior reservoir, partially encircling the chamber, contains compressed air, which is admitted to the chamber by a faucet, as the air may become vitiated by breathing. The opening of another faucet permits the vitiated air to escape through the tube which leads to the surface of the water. If the

Fig. 361.



Philips's Submarine Armor.

operator wish to ascend without assistance, he turns another faucet, which permits air to pass from the chamber into a collapsed bag attached to the top of the apparatus. As the bag becomes inflated, it displaces water and renders the whole apparatus buoyant. To descend again, he closes the cock leading to the balloon, and opens another which allows the air to escape from the balloon, which is collapsed by the pressure of the water. The compressed air is intended to form a supply for the trip, the connection with the surface consisting of a lifting and lowering rope and the eduction air-pipe.

Other armor for submarine explorations consists merely of helmets which have the necessary windows to allow the diver to see his work, and are provided with induction and eduction tubes to furnish the operator with a supply of vital air and carry off that which is vitiated.

Some exploring apparatus are adapted for making observations without descending. These consist of tubes, telescopic or otherwise, the lower end being brought into near proximity to the object; and in one case — Knight's English Patent, about 1847 — a second tube was provided, down which was projected light from a lamp or the reflected light of the sun, so as to illuminate the object whose character or position it was desired to ascertain.

In 1839, Thornthwaite (England) adopted a waist-belt of india-rubber cloth, to which was connected a small, strong copper vessel charged with highly compressed air. The belt is put on in a collapsed state, and the diver descends; but when he wishes to rise, by a valve he allows the compressed air to fill the belt, which increases his levity and assists his ascent.

The armor used by Mr. Dean in 1834, when he descended to the wreck of the Royal George (sunk off Spithead, August 28, 1782), was composed of india-rubber, made perfectly water-tight, and having a metallic helmet which rested on the shoulders and admitted free motion of the head. Three glass windows admitted light and allowed the diver to examine the remains of the ship. A flexible tube was connected to an air-pump above, and admitted air to the helmet. A sinking-weight of 90 pounds was attached to his person.

A race in submarine armor took place in Boston harbor on the 4th of July, 1868. The course was 2,100 feet, reaching from Long Wharf to the Cunard Docks on the East Boston side. Each diver had a submerged direction-line, and each arrived safely, being accompanied by his boat with its usual air-pump rigging. The time made was 17, 18½, and 21 minutes respectively. Each received a prize.

Ar-mo-zine′. (*Fabric.*) A thin plain silk, generally black, and used for clerical robes.

Arms. The club was the first offensive weapon. By knots and points it became a mace; an edge and a pole converted it to a battle-axe. It was adapted for thrusting by giving it a point, and became a pike or spear; and when adapted to be thrown became a dart or javelin, which might be recovered by a line, as among the Moors. Shortened and pointed, it became a dagger or poniard, and by receiving an edge became a sword, scimeter, or similar weapon. Pointed, and associated with a motor to propel it, we see the arrow and its bow, which is, critically considered, a really beautiful invention. See ARCHERY.

"The first weapons of mankind were the hands, nails, and teeth; also stones and branches of trees, the fragments of the woods; then flame and fire were used, as soon as they were known; and lastly was discovered the strength of iron and brass. But the use of brass was known earlier than that of iron, inasmuch as its substance is more easy to work, and its abundance greater." — LUCRETIUS; d. 51 B. C. *at.* 44.

History commences after the invention of the bow and arrow, and the Australian race seems to have diverged from the parent stock before its introduction, as they, and they only, do not possess it. They have a curious analogue, however, in their flexible spears, which are bent, when adjusted for throwing, so that their reaction in straightening may increase the force of the projection. The peculiar course of their flight when they did not straighten perfectly may have suggested to them the very unique weapon, the boomerang, which was imported into England as a curiosity perhaps 30 years ago.

During the historic period we find the most ancient weapon noted in the Bible is the sword. It was the "instrument of violence," as Jacob called it, wherewith Simeon and Levi slaughtered the Shechemites (Genesis xxxiv. 25).

Phineas, the grandson of Aaron, carried a javelin. Ehud had a short dagger (Judges iii. 16). David declined Saul's sword, and used a sling, but afterward took the sword of Goliath. Many centuries before, all these weapons had been used in China, India, Assyria, and Egypt.

Pliny ascribes the invention of the sling to the Phœnicians. The Balearic Islanders were celebrated for their expertness in its use.

Slings and bows were employed by all the nations of antiquity, but among those who attained the highest military reputation, as the Greeks and Romans, were looked upon merely as auxiliary weapons, and the soldiers who used them were considered as an inferior class. The heavy-armed soldiers, who composed the strength of their armies, were armed with the spear and sword. The former, as used by the Greeks, was some 16 or even 18 feet in length, and enabled them to form a line of battle 16 men deep, — a solid mass capable of withstanding the most violent shocks, or of breaking the firmest ranks of any enemy who was not armed and disciplined like themselves; it was, however, deficient in mobility and activity. The Romans, on the contrary, preferred an order of formation and weapons which admitted of greater activity and allowed more scope to the efforts of the individual soldier. Besides a lighter spear, their principal weapon was the *pilum*, a short and massive javelin with a triangular iron head, which was darted by hand when within a few paces of their opponents, after which they drew their swords and advanced for close conflict. The Roman foot-soldier's sword was a short, two-edged weapon, greatly resembling the foot-artillery sword formerly used in the United States Army, and was adapted for either cutting or thrusting, though the soldier was instructed to prefer the latter as more effective and permitting him to preserve a better guard of his own person.

The formation of the legion was in eight ranks, and a distance of three feet was preserved between each file, as well as each rank, thus allowing ample room for the maximum effort of each separate man.

The offensive arms of the cavalry were a javelin and a long broadsword.

Cavalry does not seem to have performed such an important part among the Greeks and Romans as it did among the more Eastern nations, as the Parthians, whose mounted archers, on more than one occasion, defeated and almost annihilated the legions of Rome.

No important change in arms, except the introduction of the cross-bow, seems to have been made until the introduction of gunpowder; though the character of the forces employed underwent a complete revolution. As Europe settled down into the gloom of the Middle Ages, disciplined armies became unknown, and the barbarous nations of the North who had overrun it, in the course of time becoming converted into peaceful tillers of the soil, had lost their former military habits, and in times of war degenerated into little better than camp followers.

Cavalry, including the knights and men-at-arms by whom they were attended, constituted almost the entire strength of an army, and being nearly invulnerable to the ordinary weapons used by the footmen of that day, such as pikes and bills, were capable of putting to flight or slaughtering with impunity many times their own number of the latter, who were in general destitute of armor of any kind. The introduction of fire-arms has gradually effected an entire change in the composition and discipline of modern armies, and though the lance and sword or saber are still employed, they are used merely as auxiliaries. See ARTILLERY, FIRE-ARMS, PROJECTILES, etc. For a list of arms of various kinds, cutting, missile, etc., see WEAPONS.

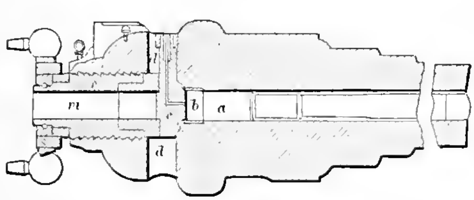
"Ships' arms are cannons, carronade, mortars, howitzers, muskets, pistols, tomahawks, cutlasses, bayonets, and boarding-pikes." — ADMIRAL SMYTH.

Arm'-saw. Another name for the hand-saw.

Arm'strong Gun. A description of ordnance adopted in the English artillery for all field-guns and many of larger caliber.

It is built up of different parts, so disposed as to bring the metal into the most favorable position for the strain to which it is to be exposed. See CANNON.

Fig. 362.



Armstrong Gun.

The illustration does not show the mode of *building up* the gun, but illustrates the mode of breech-loading. The inner portion of the barrel is made of coiled iron or steel, welded; that mode of constructing being adopted to avail the tensile strength of the metal in resisting the bursting force of the discharge. The mode of reïnforcing differs somewhat in the different calibers and styles of the arm, but consists, generally speaking, of a number of reïnforce bands of superior strength and thickness, over and in the vicinity of the charge-chamber and the parts weakened by the transverse cavity in which the breech-block is slipped.

a is the charge-chamber.

b the gas-check.

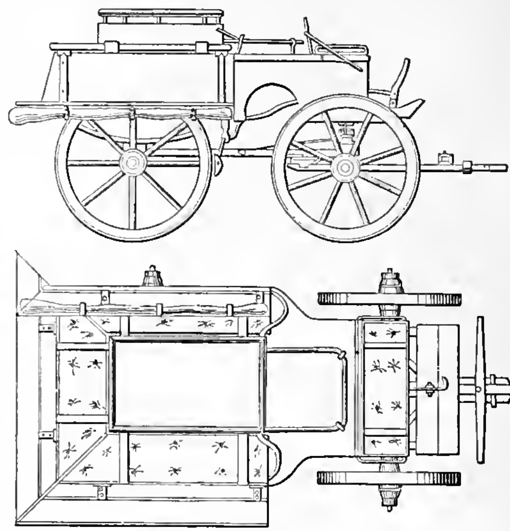
c is the breech-block which slides in a transverse slot *d*. The breech-block is traversed by the vent.

e is a breech-screw having an axial aperture *m*, through which the charge is introduced from the rear, when the breech-block *c* is withdrawn. After the charge is inserted in the chamber *a*, the block *c* is replaced, and the breech-screw *e* is screwed up, forcing a projection on the anterior face of the breech-block into the conical seat at the rear of the bore, and tightening the gas-check *b* in its seat, to prevent any escape of gas rearwardly.

Ar'mure. (*Fabric.*) A lady's dress-goods, having a cotton chain and woolen filling, twilled.

Ar'my Wag'on. A wagon designed for the use of foot-soldiers on the plains, and so constructed

Fig. 363.



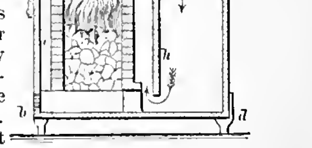
Army Wagon.

that the men can quickly jump off the seats when attacked, and spring back again at once. The term is also applied to wagons for stores and ammunition.

Ar'nott's Stove. The original form of Dr. Arnott's stove is shown in Fig. 364, and perhaps illustrates its peculiar principle better than do the subsequent modifications.

a b d represent a box of sheet-iron, divided by the partition *g h* into two chambers, communicating freely at the top and bottom; *c* is the fire-box, formed of iron, lined with fire-brick and resting on a close ash-pit with a door at *b*, near which is a valved opening by which air enters to feed the fire when the door is shut; *i* is the door of the stove by which fuel is introduced; *e* is the chimney-flue. When the ash-pit door and the stove-door are shut, the quantity of air admitted by the valved opening in the ash-pit is only just sufficient to support combustion, and only a small corresponding quantity of air can pass away by the chimney. The whole box then soon becomes filled with hot air, or smoke from the fire circulating in it, and rendering it everywhere of as uniform temperature as if it were full of hot water. This circulation takes place,

Fig. 364.

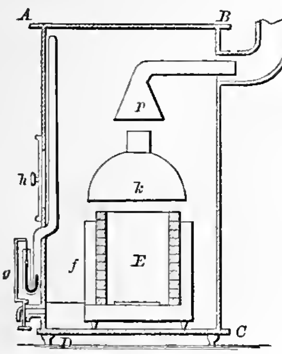


The Arnott Stove.

because the air in the front chamber around the fire-box, and which receives as a mixture the hot air issuing directly from the fire, is hotter, and therefore specifically lighter, than the air in the posterior chamber, which receives no direct heat, but is always losing heat from its sides and back; and thus, as long as the fire is burning, there must be circulation. The whole mass of air revolves, as marked by the arrows, with great rapidity. The quantity of new air rising from within the fuel, and the like quantity escaping by the flue *c*, are very small, compared with the revolving mass. The methods of regulating the supply of air will be noticed presently.

With this stove, Dr. Arnott, during the severe winter of 1836–37, was able to maintain in his library a uniform temperature of from 60° to 63°. The quantity of coal used (Welsh stone-coal) was, for several of the colder months, 6 lbs. a day, — less than two cents' worth, — a smaller expense than that of the wood used in lighting an ordinary fire. The grate or fire-box, fully charged, held a supply for twenty-six hours. Another common form of this stove is shown in Fig. 365. *A B C D* is the outer casing; *E* the fire-box over which is a dome *k*, with a funnel *p*, to carry off the products of combustion; *h* is the stove-door, and *g* the regulator by which air is admitted. The device for automatically regulating the supply of air is described under THERMOSTAT (which see).

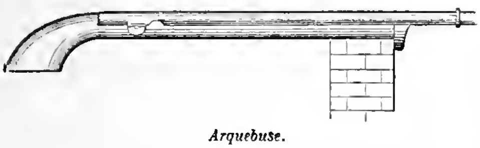
Fig. 365



The Arnott Stove.

Ar'que-buse. This piece, an early attempt at a portable fire-arm, had a massive stock laid to the shoulder, and an offset near the muzzle by which it might be rested against an object, to break the recoil. It was fired by a match. It was used in the battle of Morat, where the Swiss defeated Charles the Bold, 1476.

Fig. 366.

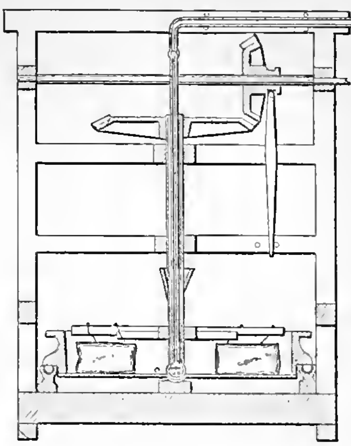


Arquebuse.

Ar-ras'tra. One form of machine for comminuting ore. The name is derived from the Spanish word meaning "to drag," and is indicative of the machine. It consists of a pan in which the ore is placed, and a vertical rotating post, to whose radial arms are attached thongs by which blocks or mullers are dragged over the ore in the pan. They are very common in Mexico, where they operate upon argentiferous ores, and, according to Humboldt, do excellent work. They have been superseded to some extent by other forms of grinding-mills. See AMALGAMATING MILLS; ORE-STAMP; ORE-CRUSHER.

Three arrastras are patented in the United States.

Fig. 367.

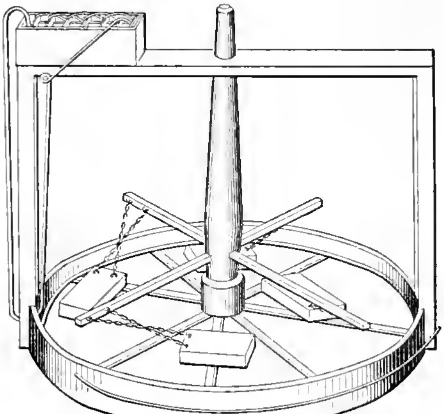


Arrastra.

Fig. 367 has the distinct arrastra characteristics, and is designed for the reduction of precious metals from ores and tailings: it has a cast-iron pan provided with two flanges, placed on opposite sides, and terminating in a ball-pivot, which rests in a cup-shaped bearing on the frame, by which means the arrastra can easily be tipped when the contents are to be drawn off. A cup-shaped cavity serves also as a bearing for a ball-pivot at the lower end of the hollow shaft.

In another form the circumferential band on the inside surface of the arrastra is connected with the

Fig. 368.

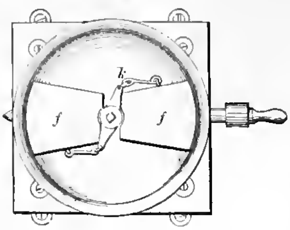


Arrastra.

positive pole of the battery, and the metallic radial gutters are attached to the encircling wire connected to the negative pole. The arrastras being filled with the pulverized ore, water, and mercury, the electric current is caused to pass through the mass, and is intended to facilitate the separation of the metals from their chemical combinations, and further their amalgamation with the mercury.

Fig. 369 is designed as an improvement on the Bertola Mill, October 20, 1857, but differs from it in the fact that the mullers *f* are linked to the arms

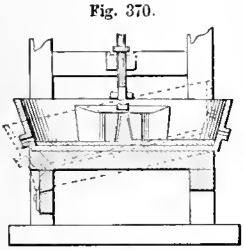
Fig 369.



Bertola's Arrastra.

k of the rotating-shaft, so that each is free to accommodate itself to the material over which it is dragged. The basin in which the mullers revolve consists of a circular iron trough through whose center the rotating axis passes up, being driven by machinery beneath. The muller, in his former patent, was not operated as in an arrastra, was not dragged, but was a block slipped over the central boss in the pan, and formed of an annular disk from whose opposite edges a portion was removed, leaving concave sides. The bottom of the muller was grooved, and the part removed left spaces for the ore on each side, between it and the basin. It was revolved by a shaft above, lowered into operative contact with it as required, and the pulp was discharged by openings near the bottom, which were unstopped when the pan was tilted on a horizontal axis. Openings above and at the bottom, respectively, discharge the water and the amalgam pulp.

Fig. 370.



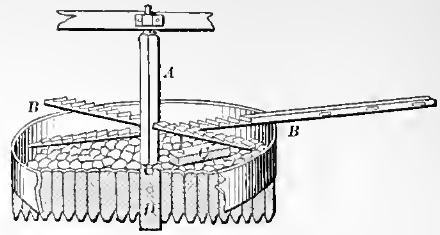
Bertola's Mill, 1857.

The arrastra, as usually constructed, and described by Phillips, consists of a circular pavement of stone, about twelve feet in diameter, on which the quartz is ground by means of two or more large stones or mullers dragged continually over its surface, either by horses or mules, but more frequently by the latter. The periphery of the circular pavement is surrounded by a rough curbing of wood or flat stones, forming a kind of tub about two feet in depth, and in its center is a stout wooden post, firmly bedded in the ground, and standing nearly level with the exterior curbing.

Working on an iron pivot in this central post is a strong, upright wooden shaft, secured at its upper extremity to a horizontal beam by another journal, which is often merely a prolongation of the shaft itself. This upright shaft is crossed at right angles by two strong pieces of wood, forming four arms, of which one is made sufficiently long to admit of attaching two mules for working the machine. The grinding is performed by four large blocks of hard stone, usually porphyry or granite, attached to the arms either by chains or thongs of rawhide, in such a way that their edges, in the direction of their motion, are raised about an inch from the stone pavement, while the other side trails upon it. These stones each weigh from three to four hundred pounds, and in some arrastras two only are employed, in which case a single mule is sufficient to work the machine. Fig. 371 is a sectional view of a Mexican arrastra as usually constructed; *A* is the upright shaft; *B*, the arms, to which the mullers *C* are attached; and *D*, the central block of wood in which the lower bearing works.

Some of the arrastras used by Mexican gold-miners, for the purpose of testing the value of quartz veins, are very rudely put together, the bottom being made of unhewn flat stones laid down in clay; but in a well-constructed arrastra, intended to be permanently employed, the stones are carefully dressed and closely jointed, and after being placed in their respective positions, are grouted-in with hydraulic cement.

Fig. 371.



Mexican Arrastra.

Ar-rest'er, Light'ning. An instrument used on telegraph-lines, by which static electricity of high tension (lightning) is discharged from the line to the earth, to prevent injury to the telegraph instruments or the operators.

It consists of an interposed resisting medium which is traversed by a current of high tension, and allows the charge to pass to the earth, but which opposes the passage of the ordinary voltaic current. See LIGHTNING ARRESTER.

Ar'ris. The external angle or edge formed by the meeting of two plane or curved surfaces, whether walls, or the sides of a stick or stone.

Ar'ris-fil'let. A triangular piece of wood placed under a lower course of slates, tiles, or shingles.

Ar'ris-gut'ter. (*Carpentry.*) A V-gutter fixed to the dripping-eaves of a building.

Ar'ris-pie'ces. The portions of a built mast beneath the hoops.

Ar'ris-wise. Diagonally arranged; said of tiles or slates.

Ar'row. The missile which is projected by a bow. Bundles of arrows were called *sheaves*.

It is usually of reed or of wood, and tipped with the best accessible materials; such as bone, flint, obsidian, metal.

The old English rule was to have the arrow half the length of the bow, and the latter the length of the archer, so that a *cloth-yard shaft* was used by a man six feet high.

The *bolt* was a peculiar arrow adapted to be shot from a cross-bow. The arrow of an arbalest was termed a *quarrel*.

Immense quantities of flint arrow-heads are found in the Celtic barrows throughout Europe. The arrow-heads of the Scythians and Greeks were of bronze, and had three flanges like a bayonet; such have been found at Persepolis and Marathon. The "barbarians," say the classic writers, use barbed (*aduncæ, hamatæ*) and poisoned (*venenatæ*) arrows. The poison on the arrow was called *toxicum*, from its relation to the bow, and the word was extended to poison in general.

The shaft was of polished wood, cane, or reed. The latter actually gave names to the weapon,— *arundo, calamus*. The Egyptians used reed shafts; their arrows were from 22 to 34 inches in length, and are yet extant.

The monuments show feathered shafts.

In the time of Homer, arrows were sometimes poisoned. The poisoned arrows of the Indians of Guiana are blown through a tube. They are made of the hard wood of the *Cokarito* tree, are about the size of a knitting-needle nine inches long, and mounted on a yellow reed four or five feet long. One end is sharpened, and poisoned with *woorai;* the rear end receives a pledget of cotton to act as a piston in the tube. The effective range is about forty yards. The hardwood spike can be removed at pleasure; twelve or fifteen such spikes are carried by the hunter in a little box, made of bamboo. The poisoned spike is cut half through, at about a quarter of an inch above the point where it fits into the socket of the arrow; and thus, when it has entered the animal, the weight of the shaft causes it to break off, the shaft falls to the ground uninjured, and is fitted with another poisoned spike and used again.

In like manner the arrows of the Bushmen, Africa, often have the shafts partly cut through, so that they may break and leave the point in the wound.

The serrated weapon of the sting ray is used by the Malays for heading some of these blow-arrows, with the express intention that they might break off in the wound.

The arrow-heads of the Shoshones of North America, said to be poisoned, are tied on purposely with gut in such a manner as to remain when the shaft is withdrawn.

A similar idea is carried out in a Venetian dagger of glass with a three-edged blade, having a tube in the center to receive poison. By a certain wrench the blade was broken off, and remained in the wound.

"In passing overland from the Essequibo to the Demerara," says Waterton, "we fell in with a herd of wild hogs. An Indian let fly a poisoned arrow at one of them; it entered the cheek-bone and broke off. The hog was found dead about 170 paces from the place where he had been shot. He afforded us an excellent and wholesome supper." The wild tribes of the Malayan peninsula, who use poisoned arrows, eat the meat of animals killed by these deadly weapons, without even troubling themselves to cut out the wounded part.

There is reason for supposing that the discovery of the various poisons used for weapons, and the practice of applying them to such a purpose, arose spontaneously and separately in the various quarters of the globe. Poisoned weapons are used by the Negroes, Bushmen, and Hottentots of Africa; in the Indian Archipelago, New Hebrides, and New Caledonia. They are employed in Bootan, Assam, by the Stiens of Cambodia, and formerly by the Moors of Mogadore. The Parthians and Scythians used them in ancient times.

The composition of the poison varies in different races; the Bushmen, Hottentots, and others, using the venomous secretions of serpents and caterpillars. In the Bosjesman country, Southern Africa, the natives hunt the puff-adders, in order to extract the poison. They creep upon the reptile unawares, and break its back at a single blow. The poison-glands are then extracted; the venom is very thick, like glycerine, and has a faint acid taste. This is mixed, on a flat stone, with an acrid poisonous gum, called "parki"; after being worked until it becomes of the consistency of thick glue, it is spread over the barbed head of the arrow and for about two inches up its point. The arrows are then dried in the sun. Each warrior carries some half-dozen of these devilish weapons, a wound from one of which is as deadly as the bite of the adder itself.

In Ceylon the cobra-tel poison is extracted from certain venomous snakes, such as the Cobra de Capello (from which the poison takes its name), the Carawella, and the Tic polonga; arsenic and other drugs are added, and the whole is "boiled in a human skull." Three Kabra-goyas (*Hydrosaurus salvator*) are tied near three sides of the fire, with their heads toward it; they are tormented with whips to make them hiss, so that the fire may blaze! The froth from their lips is added to the boiling mixture, and as soon as an oily scum rises to the surface, the "cobra-tel" is complete. Probably the arsenic is the most active ingredient in this poison.

The Ceris are said to prepare poison for their arrows in the following manner: "They first kill a cow, and take from it its liver; they then collect rattlesnakes, scorpions, centipedes, and tarantulas, which they confine in a hole with the liver. The next process is, to beat them with sticks, in order to enrage them; and, being thus infuriated, they fasten their fangs and exhaust their venom upon each other and upon the liver. When the whole mass is in a state of corruption, the women take their arrows and pass their points through it; these are then allowed to dry in the shade."

The Indians of Choco and Barbacoas use the "Veneno-derana," or frog poison, which is obtained by placing a species of yellow frog, that frequents the swamps, over hot ashes, and scraping off the viscid humor that arises. After thus torturing the frogs, they are allowed to escape, in order that they may serve another time. "Veneno-de-culebra," or snake poison, is also said to be used in Choco.

(*Fortification.*) An advanced work at the foot of the glacis, consisting of a parapet whose faces form a salient angle. It has communication with the covered way cut through the glacis.

(*Surveying.*) One of the iron-wire pins employed in marking the chainage. One is placed in the ground at the end of each chain.

An *arrow* is ten inches long, with a loop at the upper end, and is all the better for a red flag to render it conspicuous.

Called also a *chain-pin.*

Ar'se-nic. A soft, brittle, and poisonous metal of a steel-gray color. Equivalent, 75; symbol, As.; specific gravity, 5.7. It volatilizes, exhaling an odor of garlic; fuses at 400° Fah., and is easily inflamed. It combines with oxygen in two proportions, forming arsenious and arsenic acids. The former salt is As. 75, O. 24; the latter, As. 75, O. 40. The former is the common white arsenic of commerce, very poisonous, and a dull white powder, sp. gr. 3.07.

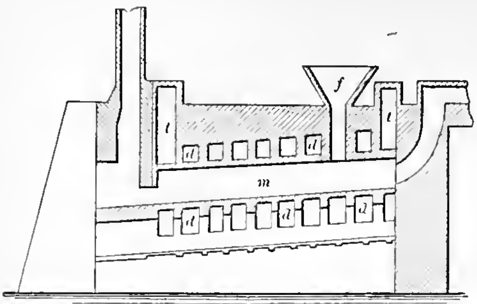
It is used to alloy lead for shot-making, causing the metal to pour more readily, and hardening the shot.

Ar'se-nic Fur'nace. A furnace in which arsenical pyrites is decomposed by heat, producing white arsenic, which is an oxide of the metal chemically known as arsenious acid, the arsenic of commerce. Arsenic is combustible, oxidizing so rapidly as to burn with a livid flame, the fumes being condensed in large chambers which resemble the successive stories of a house. The floors have openings, so that the fumes traverse each apartment, and the light powder is deposited.

The furnace is a muffle *m*, with an inclined sole, and having a fire-chamber beneath. The sole rests upon brickwork which has numerous openings, forming circulatory flues *d* around the muffle. The arsenical pyrites is introduced at the hopper *f*, and the smoke escapes by the flues *t t*.

The condensing chambers have openings by which the collected arsenic on the respective floors is removed, the lower chamber being entered by the duct *o*, which proceeds from the muffle.

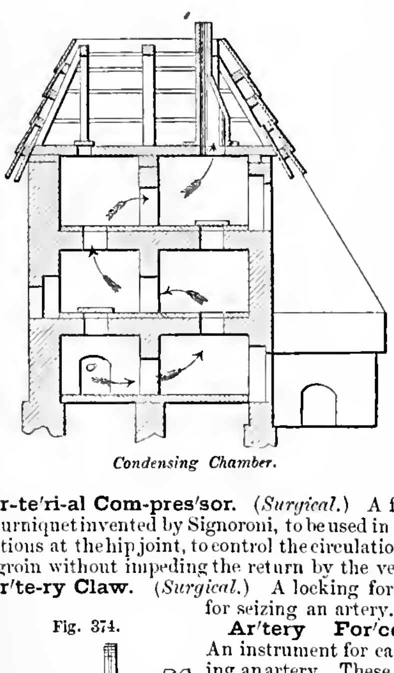
Fig. 372.



Arsenic Furnace.

The deposit in the lowest chamber is the purest.

Fig 373.

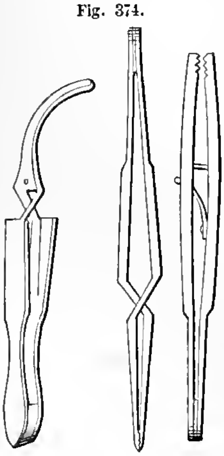


Condensing Chamber.

Ar-te′ri-al Com-pres′sor. (*Surgical.*) A form of tourniquet invented by Signoroni, to be used in amputations at the hip joint, to control the circulation at the groin without impeding the return by the veins.

Ar′te-ry Claw. (*Surgical.*) A locking forceps for seizing an artery.

Fig. 374.



Artery Forceps.

Ar′tery For′ceps. An instrument for catching an artery. These forceps are made straight, curved, plain, or rat-toothed, spring-open, spring-shut, or catch.

The illustration shows three forms.

Ar′te-ry-o-tome′. A post-mortem or dissecting instrument, for slitting an artery.

Ar-te′sian Well. Artesian wells are so called because it was generally supposed that they were first used in the province of Artois, France. They appear, however, to have existed in Egypt at a very remote date, and are said to be found in the province of On-Tong-Kiao, in China, of the depth of from 1,500 to 1,800 feet. The principle of their action is this: water percolating through pervious strata, such as sand, gravel, or chalk, is finally arrested in its downward course by an impervious stratum of rock or clay, causing it to accumulate in the pervious stratum above as in a reservoir, and when the source of supply is higher than the level of the ground at the place where the well is bored, the water will rise to the surface, or even considerably above it; in many cases issuing from the mouth of the well with sufficient force to throw a jet of the water to a great hight, or admit of its being carried high enough for distribution to the upper stories of buildings.

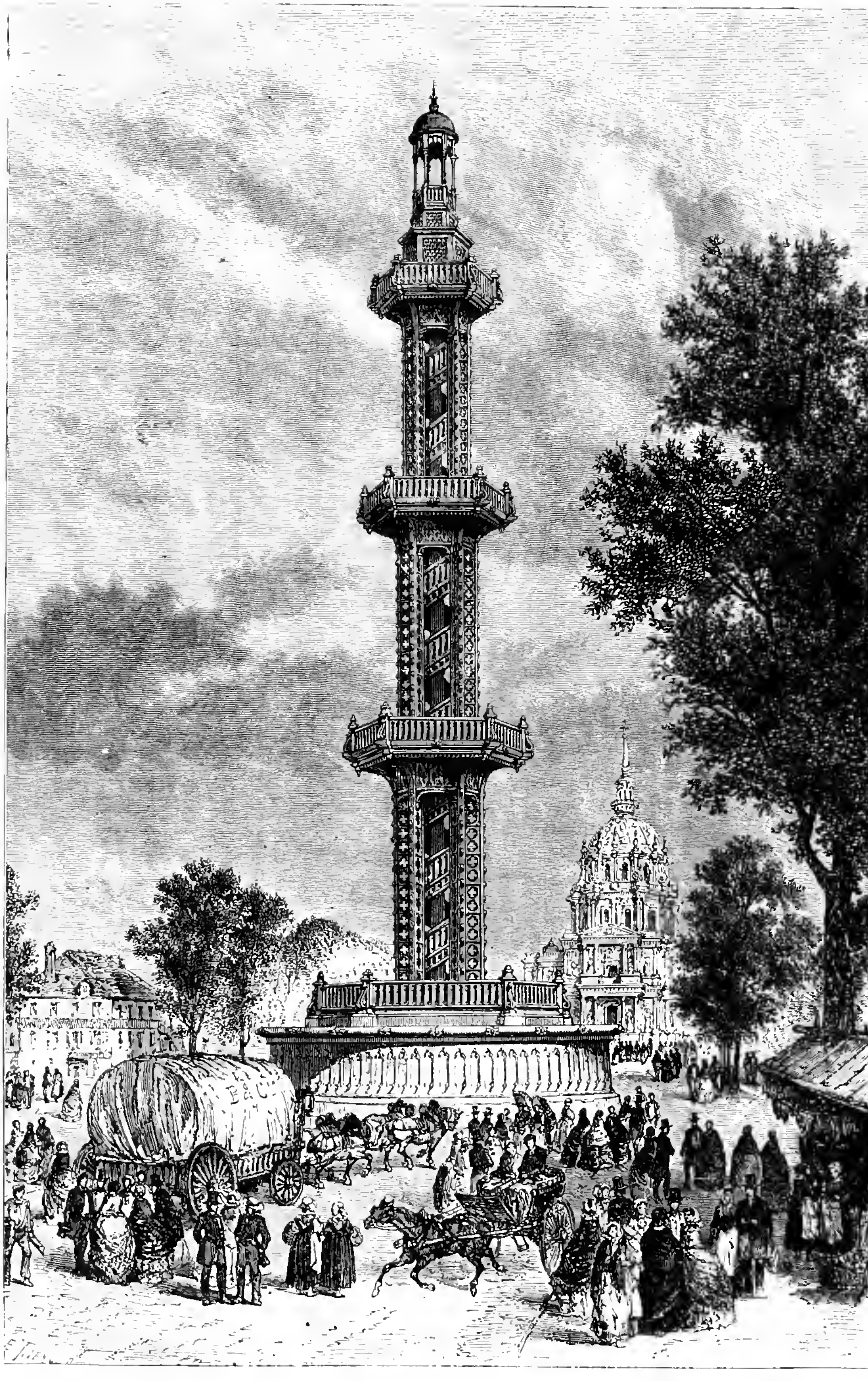
The term "artesian" is only properly applied to wells in which the water rises to or above the surface, so that in case a large number are collected in a single neighborhood, some or all of them, particularly those toward the higher part of the basin, may become converted from artesian into ordinary wells. In the London basin, where a great number of artesian wells have been bored, the general level of the water has been very much diminished.

It generally happens that more than one, frequently many, water-bearing strata are penetrated before one is reached which has a sufficient head to cause an overflow at the surface; in such cases others besides the lower one may be made available, if thought advisable.

The wells of the London basin will perhaps afford as good an illustration of the theory and action of artesian wells as any other example; the character and succession of the beds having been more carefully studied and worked out than almost any others where such wells are located.

These wells derive their supply from the pervious strata of the plastic clay and chalk. These strata are covered in part by the formation called the London clay, which is, in most of its beds, tough and impermeable to water, so that the rain falling on those parts of the porous chalk and other pervious strata below it, which are not covered by the superjacent impervious clay, percolates through them till its farther progress downward is stopped by the "gault," another stratum of impervious clay, and accumulates tween it and the overlying clay, which acts as a cover to this vast subterraneous reservoir to the level of the line *B A*. The water, reaching points, as *C*, at the lower levels of the junction of the chalk and clay, the pervious and the impervious strata, comes to the surface in the form of springs which act as discharge-outlets. In this case a horizontal line, as *A B*, drawn through *C*, indicates the general level of the water in the basin, unless disturbed by faults or shifts in the strata permitting a part to be carried off at a lower level. In the latter case, if the outlet had an area of capacity for carrying off an amount in excess of the supply received from the clouds, it would determine the water-level; if less, the level would fluctuate somewhere between this lower point of discharge and the line *A B*, in proportion to the amount of rain falling on the exposed portions of the pervious strata.

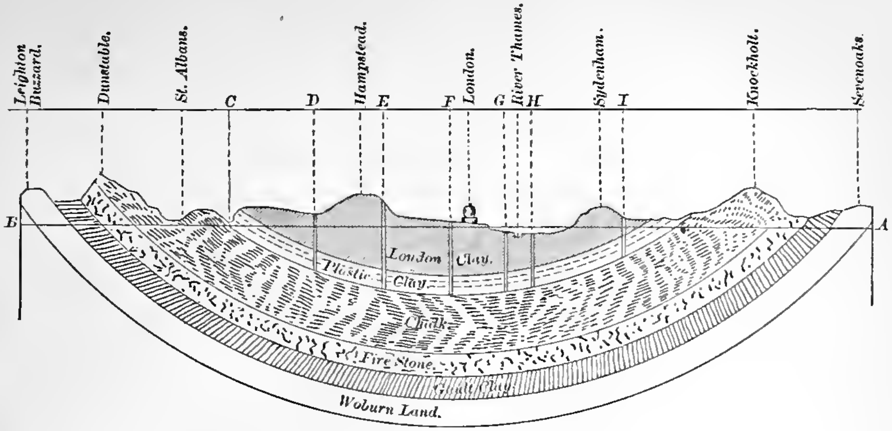
If a boring be made anywhere through the overlying clay beds, it is evident that the water will rise by hydrostatic pressure until it has attained the same level as in the chalk beds below, and if the surface of the ground at that point be below this level, the water will rise to the surface and overflow as at *G* or *H*, which it did a few years ago in the valley of the Thames between London and Brentford, though it is said that latterly there has been an average fall of about two feet per year in the wells of the London basin, so that in many of those wells



ARTESIAN WELL,

PLATE V GRENELLE, PARIS, FRANCE. See page 163.

Fig. 375.

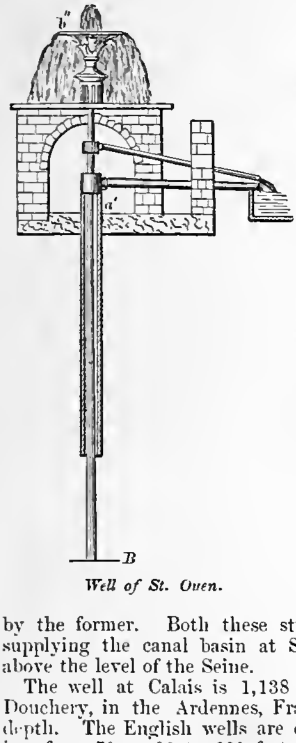


Section of the London Basin.

which formerly overflowed the water is now raised by pumps.

At St. Ouen, in France, water is brought up from two strata at different levels, the ascending force of the water from the lower stratum being greater than that in the upper. This is effected by means of two pipes, one within the other, with a sufficient interval between them to allow the free passage of water. The smallest pipe brings up the water from the lower stratum *B* to the level of the highest part of the fountain *b''*, while the water from the upper stratum, which does not attain so high a level, passes up through the outer pipe to *a'*; by this means, should the water from the lower stratum be pure and that from the upper impure, the former may be brought up and discharged separately without being mingled with or contaminated by the former. Both these streams are used for supplying the canal basin at St. Ouen, which is above the level of the Seine.

Fig. 376.



Well of St. Ouen.

The well at Calais is 1,138 feet, and that at Douchery, in the Ardennes, France, 1,215 feet, in depth. The English wells are of less depth, varying from 70 or 80 to 620 feet. The fountains in Trafalgar Square, London, are supplied by wells of this kind, 393 feet deep. Those of London are all in the chalk, and it is believed that by deeper boring, so as to reach either the upper or lower green-sand formations, a more ample supply of water could be obtained.

The essential apparatus for boring as generally practiced consists of an auger or borer attached to rods (which are successively screwed on to each other as the work progresses, and which afford a measure for the depth of the boring), and tubes of an exterior diameter equal to that of the well, which are pushed down one after another to prevent the caving in or filling up of the well by earth or rock. One of the most celebrated artesian wells is that at Grenelle, a suburb of Paris, which took nearly seven years and two months of difficult labor to complete: it is 1,802 feet in depth, and when the water-bearing stratum of green-colored sand was reached, the water was discharged at the rate of upwards of 880,000 gallons in 24 hours; the force was such that the water could be carried to a hight of 120 feet above the surface.

The temperature of the water from the depth of 1,802 feet was considerably higher than the mean temperature at the surface. In the cellars of the Paris Observatory, at a depth of 94 feet, the thermometer was found constantly to remain at 53°.06 Fah.; in the chalk, at a depth of 1,319 feet, it marked 76°.3; in the gault, at 1,657 feet, 79°.6; and the water flowing from the well has a uniform temperature of 81°.8, indicating a rate of increase of 1°.7 for each 100 feet below the limit of constant temperature.

The springs which supply the King's Bath, at Bath, England, have a temperature of 117°, and the spring of Orense, in Gallicia, has a temperature of 180° Fah.

The artesian Brine-well of Kissingen, in Bavaria, was begun in 1832, and in 1850 water was reached at 1,878 feet. The depth reached by farther boring was about 2,000 feet. The water has a temperature of 66° Fah., and issues at the rate of 100 cubic feet per minute. The ejecting force is supposed to be derived from a subterranean atmosphere of carbonic-acid gas, acting with a force of 60 atmospheres. The tubings are concentric, water rising between the outer and middle tubes, passing down between the middle and inner tubes to the bed of rock salt, where it is saturated, and then raised in the middle tube to the surface.

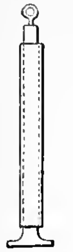
The artesian well at Passy, near Paris, is probably the largest well of the kind that has ever been sunk. It is carried through the chalk into the lower green sands, which were reached at a depth of 1,913 feet, the bore finishing with a diameter of two feet.

Six years and nine months were occupied in reaching the water-bearing stratum, when the yield was 3,349,200 gallons per day of 24 hours, subsequently increased to 5,582,000 gallons, and then continued at 3,795,000 gallons per day. The total cost of the well was £ 40,000. It was lined with solid masonry for a depth of 150 feet, then wood and iron tubing was introduced to 1,804 feet from the surface, and below that there was a length of copper pipe pierced with holes.

The variety of boring tools which have been employed in making artesian wells is very great, and the utility of some of those figured and described in works on the subject, if one may be allowed to judge from their shape and appearance, is very questionable. The mode adopted by the Chinese, who have for many ages been in the habit of boring for salt or fresh water is one of the most primitive.

Their wells are often from 1,500 to 1,800 feet deep, and bored in the solid rock. A wooden pipe five or six inches in diameter inside is sunk into the earth, and covered with a stone having the same aperture as the pipe. A steel tool weighing 300 or 400 pounds, concave above and rounded beneath, is suspended by a cord from the extremity of a lever and lowered down the tube; by leaping on the end of the lever, the piece of steel is suddenly elevated about two feet and allowed to fall by its own weight, being partially rotated at each movement. When three inches of rock have been crushed, the steel is raised by means of a pulley, bringing with it the material which has accumulated on its upper concavity.

Fig. 377.

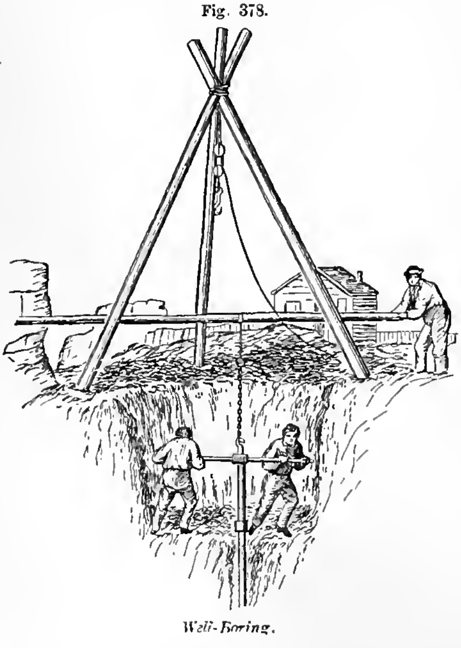


Rock-Drill.

Should the attachment of the steel head be broken, another steel head is employed to break the first, an operation perhaps requiring months. Under favorable circumstances it is said nearly two feet of rock may be penetrated in 24 hours.

A modification of the above has been employed in Europe, in which the upper part of the tool is inclosed in a cylinder (see Fig. 377). These are suspended by a rope, the twisting and untwisting of which imparts a sufficient circular motion. When the apparatus is withdrawn from the hole, the lower end of the tool closes the bottom aperture of the cylinder, which brings up the mass of comminuted rock to the surface.

Fig. 378.



Well-Boring.

A common mode of boring is shown in Fig. 378. Two men walk around and turn the handle of the boring-tool, which is screwed into an iron rod. In moderately soft ground the weight of the two men and the rotation of the handle will cause the boring-chisel to penetrate, but in rock it requires to be hammered down, the men shifting its position from time to time to enable it to act on a fresh portion of the rock. This operation is greatly facilitated by suspending the boring-rods from a beam, fixed at one end and worked by a man at the other, assisting by its elasticity the efforts of those below in alternately raising and depressing the tool to give it the necessary pounding motion. When the hole has by this means been opened as far as the length of the tool will allow, it is withdrawn, and a valved cylindrical auger (Fig. 379) introduced, which being turned, the valve is opened by the pressure of the comminuted rock or earth below, and fills the cylinder, which is then withdrawn. See AUGER; EARTH-BORING.

Fig 379.

Hole-Clearer.

For raising and lowering the apparatus, a tripod formed by three poles is erected over the mouth of the pit, from which a block and attached tackle is suspended; this is made fast to a claw, represented at Fig. 380, which is passed under the shoulders of the upper rod. When this is raised sufficiently, a fork is passed under the shoulders of the section below, the upper one is detached by means of a suitable wrench, and the lifting again proceeded with. Instead of the springing beam, a windlass is sometimes employed for giving the percussive motion to the tool; several turns of the suspending rope being taken around the windlass, the friction of the rope will be sufficient, when aided by the strength of a man having hold of the end of the rope, to prevent it from slipping when the windlass is turned, the man taking up the slack and aiding the upward motion. When the whole apparatus is raised a short distance in this way, the rope is slacked, and the apparatus falls with its whole weight, penetrating and crushing the rock below. The windlass is kept constantly in motion in one direction, and the percussive motion is maintained by alternately holding fast and slacking the end of the rope.

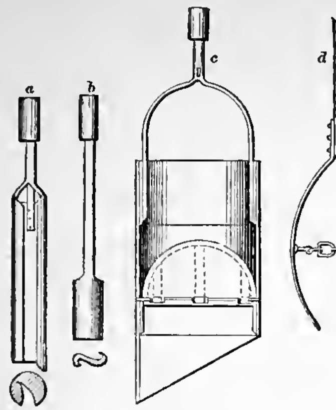
Fig. 380.

Rod-Claw.

In Fig. 381, *a* is a plan and elevation of an auger used for boring in clay or loam. *b* is an "S" chisel for hard rock. *c* exhibits a hollow valved auger for boring through sand or bringing up rock previously pulverized by the chisel. *d* is a spring reamer for enlarging a hole previously bored; this is passed down through the pipe, and, on reaching its bottom, expands to a distance regulated by the screw and swivel connecting the two spring cutters, the cutting edges of which are placed reversely. Figs. 382 and 383 exhibit different kinds of tools for earth and rock.

The rods frequently break in boring, and for raising the portion broken off below, various devices have been contrived, one of the most simple of which is represented in Fig. 384. It consists merely of a worm, which screws around the rod, which is only retained by friction when lifting. This is only available when the weight of the broken part is insufficient to overcome the friction.

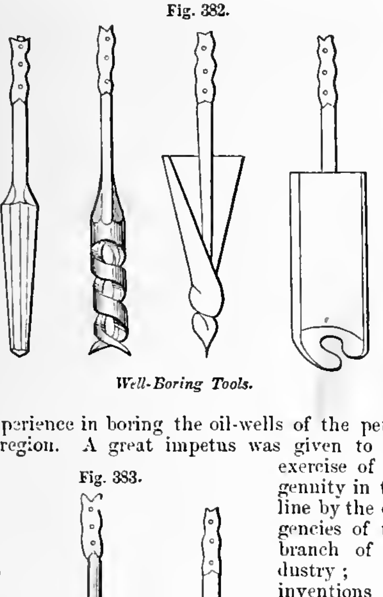
Fig. 381.



Well-Boring Tools.

The forms of boring and elevating tools which have been employed have been much modified by

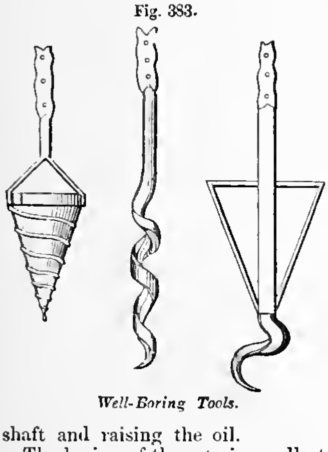
Fig. 382.



Well-Boring Tools.

the experience in boring the oil-wells of the petroleum region. A great impetus was given to the exercise of ingenuity in this line by the exigencies of this branch of industry; the inventions including boring-tools, tool-grabs, tool-jars, derricks, rod-couplings, reamers, well-tubes and couplings, tube-packing, "seed-bags," ejectors, and engines specifically adapted to sinking the shaft and raising the oil.

Fig. 383.



Well-Boring Tools.

The boring of the artesian well at Belcher's Sugar Refinery, St. Louis, was effected by a simple wedge-shaped drill, the size of which varied according to the diameter of the bore; this drill was screwed to a wrought-iron bar 30 feet long and about 2½ inches diameter, weighing several hundred pounds. To the bar was screwed a pair of slips, so that the drilling was effected by the weight of the bar alone. To this were fastened the poles, each of which was 30 feet long. These were screwed together, and were made of two pieces of split hickory-wood joined and riveted in the center. To the last pole was fastened a chain, the other end of which was attached to a spring-beam worked by a steam-engine running with a speed of about 80 revolutions per minute and having 14 inches stroke. The boring-apparatus was constantly turned by hand-power. The boring was commenced in the spring of 1849, and continued at intervals till March, 1855. For performing all the work connected with the boring, the labor of four men was, in general, daily required. This well was finished at the expiration of 33 months' steady work, and attained a depth of 2,197 feet, at a cost of $10,000; that at Grenelle, 400 feet less in depth, was more than seven years in boring, and is said to have cost about $70,000. From this depth of 2,197 feet the water can be carried to a hight of 75 feet above the surface. It is a mineral water, having a salty taste and a strong odor of sulphur, and possesses great medicinal virtues.

Fig 384.

Rod-Lifter.

The well bored at the county buildings of St. Louis Co., Missouri, has reached a depth of 3,235 feet without obtaining a flow of water.

The artesian wells at Chicago are 700 feet deep, and discharge about 1,250,000 gallons daily, with a head of 125 feet above the surface of Lake Michigan. The water is very pure and cool for the depth from which it comes, having a temperature of 57°.

The well at Louisville, Kentucky, is even deeper than this, and yields a medicinal water allied in quality to the Blue Lick and Big-Bone Lick, springs of the same state.

Some years ago a boring was commenced in the public square surrounding the State House at Columbus, Ohio, with the intention of endeavoring to obtain a head of water which could be carried to the upper part of that building for its ordinary supply, as well as in case of fire, etc. A depth of rather more than 2,700 feet was penetrated, mostly, if not entirely, through Silurian strata, but none was reached where the water had a sufficient head to rise to the surface.

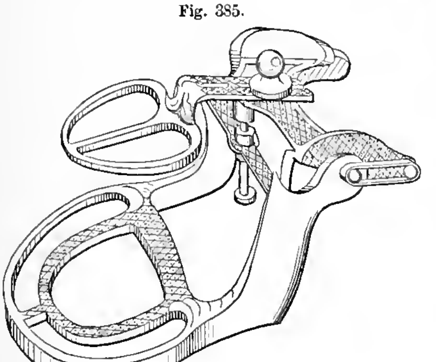
Artesian wells were made in ancient times in the Oasis of El-Bacharich, and were described by Olympiodorus, a native of Thebes, who lived in the fifth century A. D. Their depth is said to be from 200 to 500 cubits, and the water issues at the surface. They have been noticed by Arago. A Frenchman has reopened several of those which had become stopped. The reopened wells are from 360 to 480 feet deep.

The *Moniteur Algérien* gives an interesting report on the newly bored Artesian wells in the Sahara Desert, in the province of Constantine. The first well was bored in the Oasis of Oued-Rir, near Tamerna, by a detachment of the Foreign Legion, conducted by the engineer, M. Jus. The works were begun in May, 1856, and, on the 19th of June, a quantity of water, of 1,060 gallons per minute, and of a temperature of 79° Fah. rushed forth from the bowels of the earth. The joy of the natives was unbounded; the news of the event spread towards the south with unexampled rapidity. People came from long distances, in order to see the miracle; the Marabouts, with great solemnity, consecrated the newly created well, and gave it the name of "the well of peace." The second well, in Temakin, yielded 9 gallons, of 79° temperature, per minute, and from a depth of 279 feet; this well was called "the well of bliss." A third experiment, not far from the scene of the second, in the Oasis of Tamelhat, was crowned with the result of 33 gallons of water per minute. The Marabouts, after having thanked the soldiers in the presence of the whole population, gave them a banquet, and escorted them in solemn procession to the frontier of the oasis. In another oasis, that of Sidi-Nached, which had been completely ruined by the drought, the digging of "the well of gratitude" was accompanied by touching scenes. As soon as the rejoicing outcries of the soldiers had announced the rushing forth of the water, the natives drew near in crowds, plunged themselves into the blessed waves, and the mothers bathed their children therein. The old Emir could not master his feelings; tears in his eyes, he fell down upon his knees, and lifted his trembling hands, in order to thank God and the French. This yields not less than 1,136 gallons per minute, from a depth of 177 feet. A fifth well has been dug at Oum Thiour, yielding 29 gallons per minute. Here a part of the tribes of the neighborhood commenced at once the establishment of a village, planting at the same time hundreds of date-palms, and thus giving up their former nomadic life.

Ar-tic'u-la-tor. 1. An apparatus for obtaining correct articulation of artificial dentures.

The lower plate is modeled from the natural jaw,

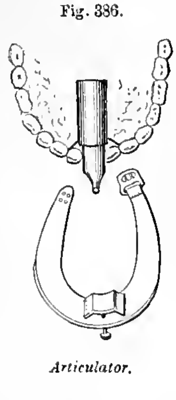
Fig. 385.



Denture Articulator.

and moves on cone-shaped pivots in V-shaped grooves without hinges, being retained in position by elastic rubber bands or rings. A backward, forward, and lateral motion is provided for, corresponding with the movements of the natural jaw, by which the arrangement of the denture can be practically tested without disturbing the articulation. The upper plate has a backward and forward movement of two inches, and may be retained at any point by the set-screw. The upper plate has a double bend, so that, when reversed from the position shown in the cut, an increase of one inch in the space is obtained between the plates, allowing for both upper and lower dentures.

Fig. 386.



Articulator.

2. An instrument for the cure of stammering. A tube in the mouth permits the passage of air, when the muscles of the mouth are suddenly closed by spasmodic action. A strap around the throat has a pad whose pressure is regulated by a spring. Its action is to keep the glottis open, and prevent the spasmodic constriction which is the cause of the trouble in articulation.

Ar-ti-fi'cial ———. An object imitating nature, such as an artificial *stem* or *flower;* sometimes having a prosthetic purpose, as an artificial *limb* or *eye*.

See under the respective heads: —

Arm, Artificial.	Leather, Artificial.
Auricle "	Leech "
Cork "	Leg "
Ear "	Limb "
Eye "	Nipple "
Flowers "	Nose "
Foot "	Palate "
Fuel "	Pearls "
Gems "	Pupil "
Gums "	Stone "
Hand "	Teeth "
Horizon "	Tympanum "
Horn "	Wood "
Ivory "	

Ar-til'ler-y. The word seems to have a very extended signification, having been originally applied to military engines of every description capable of throwing heavy missiles, as the ballista, catapult, etc. Uzziah made use of them at Jerusalem 810 B. C. They are described (2 Chronicles xxvi. 15) as "invented by cunning men, to be on the towers and upon the bulwarks, to shoot arrows and great stones withal." The Chinese claim to have used cannon 618 B. C., and engines for throwing heavy stones were used in Sicily 300 B. C. Each Roman Legion under the early emperors was furnished with an artillery train, consisting of 10 larger and 55 smaller engines for throwing stones and darts, which accompanied it on its marches. These engines appear to have corresponded to the siege artillery of modern times, and were merely employed in the attack and defence of fortified places. Their want of portability probably prevented them from being of much service in pitched battles on the open field. The date of the introduction of fire-arms as artillery appears involved in great obscurity. The artillery of the Moors is said to date back to 1118; from the few faint and imperfect allusions which occur here and there in old writers, it seems probable that their invention bore some analogy to rockets, or the projectile was self-propelling.

The following are some of the dates ascribed to the introduction of some military engines and artillery: —

Catapult invented by Dionysius of Syracuse, B. C.	3?9
Gunpowder artillery used in China . A.D.	85
Cannon throwing stones, weighing 12 pounds, 300 paces	757
The Moors use artillery in attacking Saragossa	1118
The Moors use engines throwing stones and darts by means of fire	1157
The Chinese employ cannon throwing round-stone shot against the Mongols . .	1232
Cordova attacked by artillery . .	1280
A mortar for destroying buildings, etc. described by Al Mailla, an Arab historian .	1291
Gibraltar taken by means of artillery .	1308
A cannon in the arsenal at Bamberg . .	1323
Balls of iron thrown by means of fire used by the Moors	1331

Ten cannon prepared for the siege of Cambray	1339
The Moors defend Algesiras against Alphonso XI. by means of mortars	1343
Four pieces said to have been used by Edward III. at Crecy	1346
An iron gun with a square bore, for carrying a cubical shot of 11 pounds' weight, made at Bruges	1346
Artillery used by the Venetians at the siege of Chioggia	1366
Artillery used by the Turks at the siege of Constantinople	1394
Red-hot balls fired by the English at the siege of Cherbourg	1418
The great cannon of Mahomet II. employed against Constantinople	1453
Louis XI. of France has twelve cannon cast to throw metallic shot, for use as a siege train.	1477
Brass cannon first cast in England	1521
Iron " " " " "	1547
Howitzers introduced	1697
Maritz of Geneva introduces the method of casting guns solid and boring them out	1749
Carronades invented by General Melville	1779

For continuation of the subject and details, see ORDNANCE; MORTARS; PROJECTILES; WEAPONS, etc.

In European services, artillery is divided into

Field Artillery	Horse Artillery
Foot "	Marine "
Garrison "	Siege "
Heavy "	Standing "

Ar-til′ler-y Car′riage. In the United States service, wrought-iron is now exclusively used as a material for garrison and sea-coast gun-carriages.

Experiments have also been made, promising a successful result, upon wrought-iron for field carriages.

The only field carriages so called now used in the United States service are those for the 3-inch rifled and the 12-pounder smooth-bore gun, the 6-pounder smooth-bore, the 12, 24, and 32 pounder howitzers having gone out of use.

The term "*field* carriages" is in the service only applied to such as are employed as light artillery: those adapted for the 4½-inch rifled, the 18 and 24 pounder smooth-bore guns being denominated *siege;* and those for the larger calibers, from 32-pounder to 20-inch, and for the larger rifled guns, being denominated *sea-coast* and *garrison.* The construction of field and siege carriages is necessarily very similar, both being intended to transport the guns mounted on them, as well as to afford a support during firing; while garrison gun-carriages are merely intended to subserve the latter purpose, not requiring to be moved, except from one front of a fortification to another.

The main wooden parts of a field gun-carriage are the stock, the cheeks, and the wheels.

For gun-carriages which are intended permanently to remain in position, an additional fixture is required, — the chassis; a frame, as the word implies, on which the carriage rests, and by means of which it is aimed in a horizontal direction, and upon which it is run backward and forward.

The iron parts of a field gun-carriage are very numerous, the principal being the *lunette* at the end of the stock; the *trunnion plates,* on which the trunnions of the gun rest; the *cap-squares,* which cover the trunnions and prevent the gun jumping off at the moment of firing; the prolonge hooks, around which the prolonge is coiled; and the bands at the ends of the cheeks and around the axle.

There are also arrangements for supporting the two rammers and sponges, the worm, and the maneuvering handspikes.

Ar-til′ler-y Lev′el. An instrument adapted to stand on a piece of ordnance, and indicate by a pendulous pointer the angle which the axis of the piece bears to the horizontal plane. By its means any required angle of elevation is given to the piece.

Ar′ti-mor-an′ti-co. An alloy of tin, sulphur, bismuth, and copper, made in imitation of the ancient jewelry. It resembles gold of 18 carats purity, and is made in Italy for factitious trinkets.

Artz′ber-ger. A device which originated on the continent of Europe, and was used in England in the early part of the present century as an intermediate between the piston-rod and the axle to be driven.

The power of the steam-engine, as in the Griffith Steam Carriage, 1821, is communicated from the piston-rods to the axle of the driving-wheels, through the means of sweep-rods, the lower ends of which are provided with driving pinions and detents, which operate upon toothed gear attached to the driving-wheel axle. The object is to keep the driving-pinions always in gear with the toothed wheels, however much the engine or carriage may vibrate.

As-bes′tus. A fibrous mineral which may be split into threads and filaments and resists fire. It is also known as *amianthus,* or earth-flax. The name indicates the substance, or rather the quality (in Greek, *asbestos,* — inextinguishable). It had many uses among the ancients. Mineralogically speaking, it is a variety of hornblende and pyroxene, and occurs in many parts of the world. It is found in great abundance in a few localities in the United States, and great attention is now directed to fitting it for the uses of the arts and manufactures.

The notices of its uses among the ancients are numerous. Herodotus refers to cloth made of it by the Egyptians. Its uses for paper, napkins, socks, drawers, handkerchiefs, are referred to by Varro, Strabo, and Pliny. Marco Polo mentions it, and Baptista Porta speaks of its being spun in Venice. Asbestus cerements and wrappings for the bodies of the dead previous to incremation were in common use with those whose circumstances permitted it. Shrouds of asbestus of the time of the Roman Emperors have been discovered, and are in the museums of the Vatican and of Naples. The Romans dug their asbestus in Corsica; their mica in Spain.

Its modern uses are indicated in the following patents, and the enumeration is made at some length, as the subject has been but lately revived, and one interested can in no other way so readily reach the present state of the art, — to borrow the conventional phrase, which is as good as any other.

1. Safes, lining for: W. Marr, English, 1834.
   Hyatt, several patents, United States, 1869–70.
2. Lamp-wick: British patents:
   2071 of 1853. 145 of 1857.
   2647 of 1855. 1610 of 1863.
   Lord Cochrane, 1818.
3. Absorbent in lamps: Boyd, 1869.
   Beschke, 1866.
   in carburetors: Bassett, 1862.
4. Fire-brick and crucibles: Peters, 1862.
   English patent 2318 of 1862, asbestos, fire-clay, and graphite.
   Lewis, 1871. A covering of asbestus twisted into a rope and wound around a crucible.
5. Packing for hot-air engines: Lanbereau, 1859.
   for explosive engines: Drake, 1865.
   for steam-engines: Drake, 1865.
   combined with hair: Murphey, 1870.
   loose flock asbestus; Hoke.

6. Boiler covering: Peters, 1862.
   Hardy, 1869. Selden and Kidd, 1865.
   Murphy, 1870. Spencer, 1868.
   Riley, 1871. French, 1869.
   Murfey, 1870.
7. For forming a radiating surface, as in gas-stoves, fire-grates, and broilers.
8. In porcelain manufactures, of teeth especially, placed on the side of a muffle to isolate the biscuit from the slide, to prevent its becoming attached thereto in the process of baking.
9. As an anti-friction composition for journal-bearings, pistons, etc.
   British patent, 2048 of 1858. Devlin, 1860.
   Peters, 1862. Devlin, 1865.
   Botticher: with soapstone and cotton, 1864.
   Kelly: with graphite and iron-filings, 1870.
   Johns: with caoutchouc, 1868.
10. For molded articles: Whitmarsh, 1868.
11. For roofing cement: Johns, 1868.
   Kidwell, 1868. Moore, 1868.
12. Flooring cement: Whitmarsh, 1867.
13. Electric insulator: English patent, 362 of 1865.
14. In refrigerators: Hyatt, 1870.
15. In ink: Smilie, 1863.
16. For paper: English patent, 1413 of 1853.
   Johns, 1868. Schaeffer on Paper, an old German book, describes asbestus paper, and contains a specimen.
17. For coffins — mixed with clay: 1870.
18. For ropes strengthened with other materials, Stevens, 1870 and 1871.
19. For yarn: separated into filaments by alkaline treatment, and then treated like wool: Rosenthal's patent, 1872.

As-bes'tus Stove. A stove heated by gas and having asbestus spread over the perforated pipes, in order to obtain an incandescent mass, which radiates heat, but does not consume.

Asbestus is used for lamp-wicks; as a filling for iron safes; for firemen's clothes; and in the laboratory as a wrapper for articles which are to be consumed to ashes. See ASBESTUS.

As-cend'ing Let'ter. (*Printing.*) Capital letters, and the small ones which rise above the line. They are *b, d, f, h, k, l.*

As'ci-a. (*Surgical.*) An axe-shaped bandage.

Ash'es E-jec'tor. An arrangement on board large steam-vessels to reduce the labor of hoisting out the ashes in buckets.

A chamber or tube is formed, rising from the stoke-holes, and opening above the water-line into the sea. By means of a jet of steam the ashes are directly driven from the engine-room into the sea, through the tube, the arrangement of which prevents the possibility of its being choked up. A similar method has also been adopted on stationary land-engines whose boilers are fixed below ground.

Ash'-fur-nace. A furnace in which the materials for glass-making are fritted.

Ash'lar; Ash'ler. (*Masonry.*) 1. (*a*) *Rough Ashlar*; a block of freestone as brought from the quarry.

(*b*) *Smooth Ashlar*; a block dressed ready for use.

(*c*) *Plane Ashlar*; a block in which the marks of the tool are dressed out.

(*d*) *Tooled Ashlar*; a block in which the surface has parallel vertical flutes.

(*e*) *Random-tooled Ashlar*; a block whose groovings are irregularly cut with a broad tool.

(*f*) *Chiseled Ashlar*; a random-tooled ashlar, wrought with a narrow chisel.

(*g*) *Boasted Ashlar*; same as chiseled.

(*h*) *Pick* or *Hammer-dressed*; it is known as *Common Ashlar.*

(*i*) *Bastard Ashlar* is ashlar-work backed up with inferior work.

(*j*) *Pointed Ashlar*; the face-marking done by a pointed tool or one very narrow.

(*k*) *Rusticated Ashlar*; the face of the block projects from the joint, the arrises being beveled. It may be rough or smooth-faced, or variously tooled.

(*l*) *Herring-bone Ashlar* has a tooling of oblique flutes in ranks running in alternate directions.

(*m*) *Nigged Ashlar*; a building-block dressed with a pointed hammer.

(*n*) *Prison Ashlar*; the surface is wrought into holes.

A smooth face around the joint is called a *margin-draft.*

The walls of the principal entrance of the gate at Thebes are at their base not less than 50 feet in thickness. The stones are squared on all sides, not merely on the external faces, and are built-in solid, no *rubble-work* being introduced to fill up the space between the facing walls.

The *face* of an ashlar is the front exposed surface when built into the wall.

Flanks; the sides.

Beds; upper and lower surfaces.

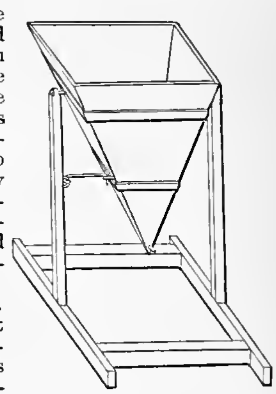
Back; rear surface.

2. (*Ashlar.*) A facing of squared stones or thin slabs used to cover walls of brick or rubble.

3. (*Carpentry.*) A vertical strut or quartering uniting the floor-joisting of the garret with the rafters above, forming the studding for the wall of the *half-story* room, cutting off an acute angle which may be utilized for closets.

Ash'-leach. A hopper in which ashes are placed while the soluble salts are removed by lixiviation. The leach is suspended upon journals which have bearings in the standards of the frame. The axis is at or about the center of gravity, so that the leach may be tipped to discharge its spent contents. A hook and staple hold it in operative position.

Fig. 387.



Ash-Leach.

Ash'ler-ing. (*Carpentry.*) Short upright pieces between the floor-beams and rafters in garrets for nailing the laths to. This cuts off the sharp angles between the floor and ceiling, giving a more convenient and tasteful appearance to the room. ASHLARING.

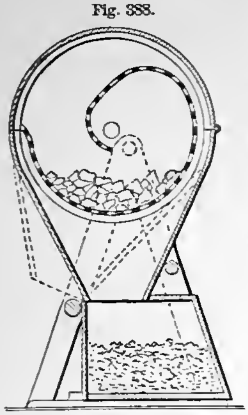
Ash'-pit. A cavity below the grate-bars of a furnace for receiving the ashes.

Ash'-plate. The back plate of a furnace.

Ash and Coal Sift'er. Sifters for coal are made on a large scale for mines, and are actuated by machinery, the object being to remove the dust which is unsuitable for ordinary stoves and furnaces. They consist of rotary wire-screens into which the coal is passed, or of a succession of inclined screens over which the coal passes by gravity, the jarring of the pieces assisting in keeping open the meshes of the screen.

For household use, as ash-sifters, they assume several forms, — rotary screens; reciprocating sieves

Fig. 388.

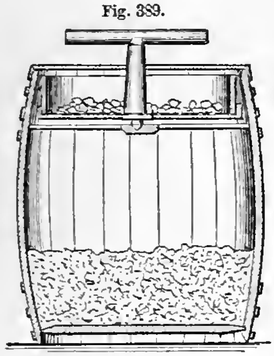


Rotary Sifter.

in boxes; oscillating sieves adapted to fit the tops of barrels; consecutive inclined sieves, which sort the material into grades; and sifters adapted to the ash-pits of stoves and furnaces.

In Fig. 388 the wire sieve is volute-shaped in transverse section, and its horizontal shaft revolves on bearings in a case. The lid of the latter opens to charge the sieve when its open mouth is presented upwardly, as in the cut. By revolving in one direction the contents are retained in the sieve, except the dust, which falls through the meshes. The operation completed, the sieve is revolved in the other direction, which discharges the larger contents into a receptacle placed to receive them.

Fig. 389.

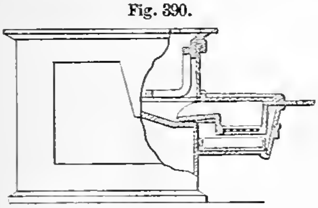


Ash-Sifter.

In Fig. 389 a central bearing is supported by radial arms inside the barrel, and supports the circular sieve which is oscillated above it. The central post of the sieve passes through a hole in the cover, and a cross-handle above affords the means of agitation.

The sifter for stove-hearths has a handle and a spout, and is placed below the hearth-plate in the ash-pit of the stove. Its office is to catch the ashes from the grate. It is vibratable in place, while the hearth-plate prevents the escape of dust. The finer portions fall into the pan below, and the contents of the sieve are thrown on the fire. There are over eighty patents on ash and coal sifters.

Fig. 390.



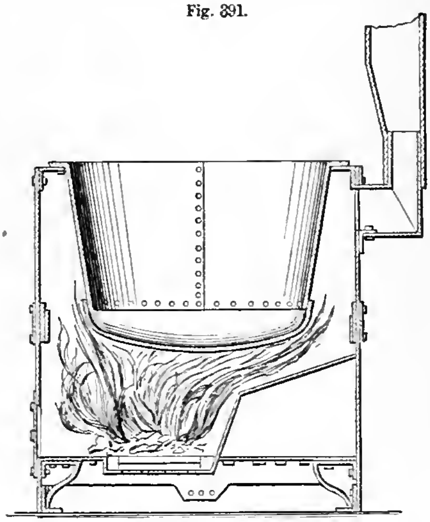
Stove-Hearth Ash-Sifter.

As-phalt′ Pave′ment. As employed in Europe, this is prepared from a dark brown bituminous limestone which is found in the neighborhood of the Jura Mountains. This stone is reduced to powder, mixed with mineral tar and grit, and the whole exposed for several hours to a strong heat in large caldrons, being continually stirred until the ingredients are thoroughly united. The composition is then run into molds forming cakes about eighteen inches square and six inches thick, and weighing 125 or 130 pounds. The blocks are laid upon good, well-rammed foundations. They do not appear to stand the wear incident to a large city, but have been laid with advantage in corridors and as pavement in railroad stations in Europe. Various analogous compounds have been patented in the United States for paving and roofing. See PAVEMENT; ROOFING.

As-phal′tum Fur′nace. Asphaltum, or native bitumen, is largely used for pavements, roads, roofs, and as a water-proof cement. For pavements, etc., it is mixed with sand or gravel, and laid while hot upon a foundation of broken stones, pebbles, or gravel. The Seyssel Asphalt is a compound of a bituminous limestone, ground fine, heated, mixed with a small portion of tar, and considerable sand. The material is brought from the Jura Mountains, and, for a while, was very popular in Europe.

Beds of mineral pitch exist in many parts of the world, and are applied as fuel, to yield a liquid hydrocarbon, for paying woodwork, as cement, and, as has been said, for roofing, paving, etc. As it requires to be laid on while hot, a portable furnace (Fig. 420) is required, from whose boiler it is ladled out and spread in its warm, plastic condition upon the surface to be treated.

Fig. 391.



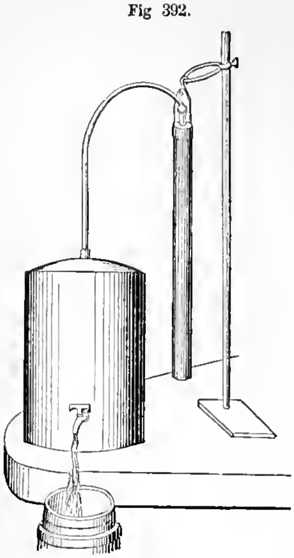
Asphaltum Furnace.

A number of formulas for compounding the material will be given under ROOFING (which see).

In laying pavement, the thickness of the asphaltum is regulated by strips of wood, dividing the space into transverse sections. The material is spread by the shovel or a wooden spatula, and the surface beveled by a floating rule which rests upon the upper edge of the strips. Slate dust, fine sand, plaster of Paris, etc., may be dusted upon the top.

As′pi-ra′tor. An apparatus for passing a regulated supply of air in contact with a contrivance which determines its chemical character or its condition, hygrometric or otherwise; or for passing given quantities of air in contact with a substance whose changes are the subject of observation. A jar filled with water is provided with a cock, by which the water is allowed to escape at a given rate. The space in the jar, above the water, is connected by a flexible pipe with the duct in which the chemical ingredients are placed or with the hygrometer chamber. The uses are various, and will readily occur to the expert, in connection with the quantitative admission of air or gases to chemical solutions,

Fig 392.

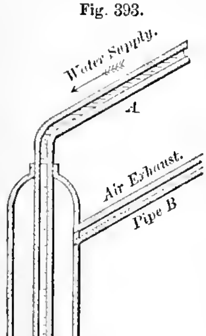


Aspirator.

ignited tapers, or organic matters. The measure of the water which has flowed from the jar is of course coincident with the air which has taken its place.

The use of the aspirator is recommended in the healing of great amputations, by Maisonneuve, Surgeon of the Hôtel Dieu, Paris. The liquids exuding from the surface of the wound coming in contact with the air, poisonous putrefaction ensues; to arrest this action, Dr. Maisonneuve, after dressing the wound with lint saturated with antiseptic liquids, brings into use an aspiratory apparatus which withdraws the contaminated air from the presence of the wound.

Fig. 393.



Sprengel's Aspirator.

A form of aspirator invented by Sprengel is now much used in the laboratories in Europe, especially in expediting filtering. The water from a reservoir passes in by the supply-pipe *A*, and drops into the discharge-pipe *C*, carrying with it a pellicle of air; this is repeated in quick succession, and the effect is to withdraw air by the pipe *B*, from the chamber with which the said pipe is connected. The discharge-pipe *C* is 30 feet long. The vacuum attained is said to be as high as 29 inches of mercury.

Sprengel used mercury, which permits a discharge-pipe of say three feet in length. Bunsen lengthened the pipe and used water.

Guerin's apparatus for this purpose consists of a hemispherical balloon provided with three tubulatures, the central and largest one being fitted with a manometer of very simple construction, a graduated glass tube terminated by an india-rubber ball filled with mercury. The ball is inclosed in the balloon, so that in proportion to the vacuum effected in the latter the former is dilated, in consequence of which the mercury in the tube falls, a scale showing the amount of fall, and hence also the degree of rarefaction in the balloon. The second tubulature receives a tube communicating with the receiver of an air-pump; and by a third, communication is effected between the balloon and each patient or hospital bed by means of india-rubber tubes, so that "pneumatic occlusion," as it is called, may be extended simultaneously to all the patients confined in the same surgical ward. There are stop-cocks for regulating the degree of vacuum in the central vessel, and the part under treatment is covered with a sort of india-rubber hood which protects it in each case from the action of the external air.

Aspirators are also used to prevent the heating of grain in bulk, by causing a constant circulation of air through its mass.

The aspirator, substantially as shown in Fig. 393, is used in maintaining a partial vacuum in the condensers of steam-engines, vacuum-pans, etc., where a discharge-pipe of 30 feet perpendicular length can be obtained.

The aspirator is also used in picking up pieces or sheets of paper, for feeding into paper-folding or envelope machines.

As-pir′ing Pump. 1. A pump in which the mechanical action is due to the forcible ejection of air from the lungs. A suction-pump.

2. A pump used to draw air from a chamber or vessel. See ASPIRATOR.

Ass. (*Paper-Making.*) A post in the bridge of a pulp-vat to lay the mold upon while the water drains from it. Used in the hand-made paper work.

As-say′. An operation for testing the proportion of any metal in an ore or alloy.

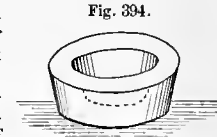
There are several modes of procedure: —

1. By specific gravity.
2. By the touchstone.
3. The wet method, — by liquid solvents.
4. The dry method, — by fluxes and fire.

As-say′ Bal′ance. A delicate balance used in assaying. See BALANCE.

As-say′ Fur′nace. A furnace with a chamber or muffle in which the metal is exposed to heat.

Fig. 394.

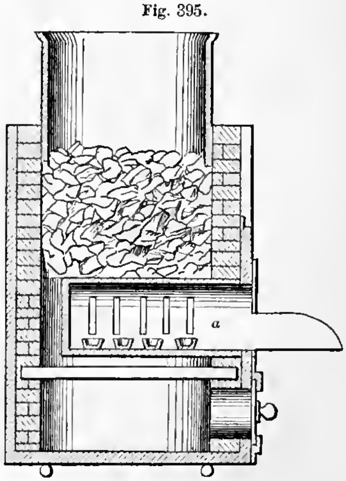


Cupel.

The furnaces used for cupellation differ considerably in shape and mode of construction: one form is represented in Fig. 395.

The muffle *a* is an oven-shaped vessel made of baked fire-clay, closed at one end and open at the other, and generally having also openings in its sides and top; its inner closed extremity usually rests on a ledge or shelf in the furnace, and its open end is luted to the entrance of the furnace, and has before it a small platform on which the hot cupels (shown on an enlarged scale in Fig. 394) can

Fig. 395.



Muffle and Furnace.

stand when withdrawn from it. In this position it can be equally heated in every part, while the apertures in the sides and top allow a current of air to pass through its interior and into the furnace itself.

As-se-gai′. A light projectile spear employed by the Kaffirs.

As-sem′bling. By assembling is understood the act of putting in their respective places and fastening together the component parts of an article composed of a number of distinct pieces, so as to form a complete and perfect whole; as, the cheeks and stock of a gun-carriage, with their connected parts; the lock, stock, and barrel of a musket, etc.

The term is more peculiarly applicable to the fitting together parts which are made strictly to fixed shapes and dimensions so as to be promiscuously interchangeable.

The system of interchangeability of parts was first introduced into the French Artillery service by General Gribeauval, about the year 1765.

Previous to this time each part of a gun-carriage was made specially for that carriage alone, and could not be used for repairing any other, unless after extensive alterations. Gribeauval simplified the system, or rather want of system, then in vogue, by reducing the carriages into classes, and so arranging many of the parts that they could be applied indiscriminately to all carriages of the class for which they were made. This system was farther simplified and extended, and was finally applied in the United States arsenals and armories to all articles made up of pieces, the improvements in machinery enabling most articles to be made accurately to pattern without depending on the eye and hand of the workman. This has been carried to a very high pitch of improvement by means of the machinery at the Colt's arms factory and other manufactories of small-arms in this country; and the beauty and utility of the system, by which exact equality of dimensions is insured in every one among thousands of almost microscopic screws and other small parts, are particularly exemplified in the work of the American watch and sewing-machine companies.

This system of interchangeability and assemblage, which by enabling a large proportion of perfect and serviceable articles to be made up from the parts of similar articles which have been broken or injured in use, instead of permitting them to be cast into the scrap-heap, is one of the most beautiful triumphs of modern mechanism.

It has proved itself capable of adaptation to large as well as small machinery, and is now applied to the locomotives of the Pennsylvania Central Railroad, whose parts are made interchangeable.

The first notice in this country of this excellent mode of manufacturing a number of articles designed to be exactly similar, is the breech-loading rifle of John H. Hall, of North Yarmouth, Massachusetts, patented May 21, 1811, and which he refers to in the following terms in a letter to the War Department: "Only one point now remains to bring the rifles to the utmost perfection, which I shall attempt if the government contracts with me for the guns to any considerable amount, namely, to make every similar part of every gun so much alike that it will suit every gun, so that if 1,000 guns are taken apart and the limbs thrown promiscuously together in one heap, they may be taken promiscuously from the heap and will all come right."

In 1816, 100 of these arms were made; 2,000, in 1827. In 1836 Congress voted $10,000 to Hall, being at the rate of one dollar per arm for all made on his principle to date.

As-sem′bling Bolt. One used for holding together two or more removable pieces, as the cheeks and stock of a field gun-carriage.

As-sis′tant En′gine. An accessory locomotive, to assist the ordinary train engine in ascending heavy grades.

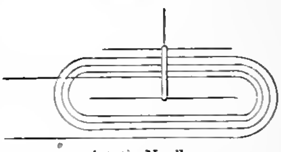
A donkey engine. A small engine used in operating a large one for moving the lever, or carrying the fly-wheel over a dead-center.

As-size′. A layer of stone, or one of the cylindrical blocks in a column. The number of *assizes* in the Great Pyramid was 203 (Kenrick). Several have been removed from the apex, which now presents a platform of 25 feet square. The *assizes* vary from two feet two inches to four feet ten inches in depth. From five to twelve feet is the common length of the stones, except in the king's chamber.

A column is said to be *monolithic*, or else to consist of *assizes*.

A-stat′ic Nee′dle. A magnetized needle whose polarity is balanced so as to remove its tendency to assume any given direction.

Fig. 396.



Astatic Needle.

It was in 1820 that Oersted, of Copenhagen, announced that the conducting wire of a voltaic circuit acts upon the magnetic needle, and thus recalled into activity that endeavor to connect magnetism with electricity which, though apparently on many accounts so hopeful, had hitherto been attended with no success. Oersted found that the needle has a tendency to place itself at right angles to the wire, a kind of action altogether different from any which had been suspected.

If two similar magnetized needles are placed parallel, but with their poles turned in opposite directions, and are suspended by a thread without twist so as to move freely, they have little tendency to place themselves in the magnetic meridian.

The action of terrestrial magnetism upon one needle neutralizes its action upon the other, and consequently the needles remain indifferent. A needle of this description is called *astatic*, and is used in the construction of the *astatic galvanometer*.

If one of the needles be placed in a coil of wire excited by an electric current, on the passage of the current the needle is deflected; and its deflections are more considerable than those of a simple needle, because there is, in the first place, but little resistance to overcome, and secondly, because the current acts upon two needles instead of one, the upper needle being deflected in the same direction as the lower.

As′tel. (*Mining.*) Overhead boarding or arching in a gallery.

As-tig′ma-tism Ap-pa-ra′tus. (*Optics.*) An instrument for detecting the presence and amount of the defect in vision arising from a certain want of symmetry in the lens or cornea.

It may consist of two revolving rings divided to 5°, each ring being furnished with springs to hold a cylindrical glass; a diaphragm fitting in one ring, and a movable slit in the other. The object is to test whether the eye has greater power to detect distinct separation between closely ruled lines in a vertical, or horizontal, or intermediate position.

As′tra-gal. (*Carpentry.*) *a.* A small molding of a semicircular section with a fillet beneath it.

b. One of the rabbeted bars which hold the panes of a window. The *astragals* of the lanterns in the

Stevenson lighthouses are diagonal, so as not to intercept the light in the azimuth which they subtend.

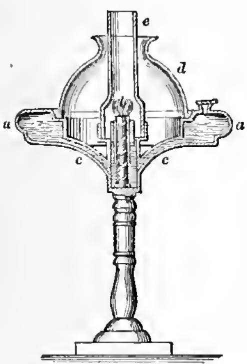
(*Ordnance.*) An outwardly curved molding. The astragal of a cannon is the molding at the front end of the chase.

As'tra-gal Plane. (*Joinery.*) A bench plane adapted for cutting astragal moldings.

As'tra-gal Tool. A wood-turning chisel having a semicircular concave face, for turning beads and astragals.

As'tral Lamp. A lamp with an annular oil reservoir connecting by two pipes with the wick tube, the latter being on the summit of the pedestal. It is designed to obviate the interception of light by the oil reservoir, which when placed centrally casts a shade upon the table.

Fig. 397.



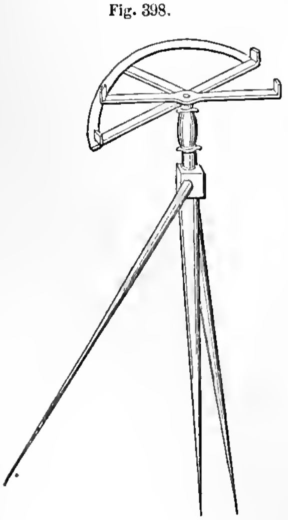
Astral Lamp.

In the arrangement shown at Fig. 397 the oil is contained in the annular chamber *a* surrounding the burner *b*, which is of the Argand kind (see ARGAND), and the lower part of the chimney, and thence descends to the foot of the wick through the two tubes *c c*.

It will be seen that the downward rays of light from the burner are not at all intercepted in the immediate vicinity of the lamp, except by the two small oil pipes, and that they are not materially interfered with, within a radius beyond which the light would be insufficient for reading or working by; even this is obviated in a considerable degree by the ground-glass globe *d* surmounting the annulus, which diffuses and equalizes that part of the light which is not cast downward. The chimney *e* assists combustion, and carries off the volatile products thereof.

As'tro-labe. The common astrolabe (not the astrolabe of Hipparchus, used in determining the altitudes of the stars) is used for measuring angles. It is graduated to degrees, and sometimes to quarter-degrees. A strip is attached in the direction of the diameter, passing through 0° and 180°, and has a tongue by which it is placed centrally upon the stand. This strip has two fixed diopters or sight-vanes. Another strip turns about the center, one end of which in the half-astrolabe (both ends in the full astrolabe) traverses the graduated limb and carries other sight-vanes. The middle line of this alidade coincides with the axis of the sight-vanes and the center, and is marked upon the beveled edge of the alidade as an index. The diopters are both ocular and objective, for fore and back sighting. A small compass may be attached at the center, and the tongue fitted up with nut and screw so as to permit the circle to be brought from the horizontal to the vertical position for the purpose of measuring altitudes.

Fig. 398.



Astrolabe.

To measure an angle with the astrolabe, the latter is placed with its center over the vertex of the angle, and turned until the fixed diopters sight in the direction of one side. The movable strip with its diopters is then sighted in the direction of the other side, and the angle contained between the two strips is read off. Telescopes may be attached in place of the alidades. Thus arranged, it becomes allied to the theodolite.

Tycho Brahe's *Astronomicæ Instauratæ Mechanica* gives several cuts of astrolabes. The astrolabes of Hipparchus, Ptolemy, Alhazen, and Tycho Brahe did not agree in all particulars of construction. They have been superseded by more improved instruments.

The astrolabe was invented to ascertain the position of the sun with regard to the ecliptic. (Whewell.) The instrument as described by Ptolemy consisted of circular rims, movable one within the other, or about poles; and contained circles which were to be brought into the position of the ecliptic, and of a plane passing through the sun and the poles of the ecliptic. See ARMILLARY SPHERE.

The *astrolabon* which Martin Behaim attached to the main-mast belongs originally to Hipparchus. When Vasco de Gama landed on the east coast of Africa, he found the Indian pilots at Melind acquainted with the use of astrolabes and cross-staffs.

As-trom'a-ra. A concave representation of the heavens.

As-trom'e-ter. An instrument invented by Sir John Herschel for comparing the intensities of light of the stars one with another by the intervention of a natural standard, such as the moon or the planet Jupiter, brighter than any of the stars to be compared, and giving an amount of light which, if not absolutely invariable, varies in such a manner that its changes are susceptible of calculation. Jupiter, being sufficiently bright, and his light being increased or diminished only in proportion to his distance from the sun, is considered as well adapted for the purpose.

The process, as described by Sir John, "consists in deflecting the light of the moon by total internal reflection at the base of a prism so as to emerge in a direction exactly coincident with that of the undeflected light of one of the stars to be compared. It is then received upon a lens of short focus, by which the image of the moon is formed, which, viewed at a considerable distance by an observer placed in or near the axis of the lens, will appear to him as a star. This artificial star is then approached to or removed from the eye until its light is judged to be exactly equal to that of the real star, which lying in nearly the same direction from the observer will be seen side by side with the artificial one by the same eye, or with both eyes at once without the aid of a telescope, as in the ordinary mode of natural vision. The distance of the eye from the focus of the lens being then measured, the prism and lens are to be placed so as to form another similar artificial star in a direction nearly coincident with that of the other star under comparison; and, another equalization being made and distance measured, it is obvious that the intensity of the lights of the two stars, or at least their effects on the retina under the circumstances of comparison, will be to each other in the inverse ratio of the distances so measured respectively."

The term "astrometer" has been also applied to an object-glass micrometer, as well as to an instrument for finding the rising and setting of stars and their positions.

As-tro-nom'i cal Clock. A clock regulated to keep regular time; *sidereal*, not *mean*.

As-tro-nom'i-cal In'stru-ments. The first phenomenon recorded in the Chinese annals is a conjunction of five planets in the reign of Tchuenhiu (2514 – 2436 B. C.). The record is verified by Fr. de Mailla and others, and identified with 2461 B. C. Saturn, Jupiter, Mars, and Venus were, with the moon, comprised within an arc of about 12° in the constellation Pisces. The emperor Yao, 2367 B. C., determined the length of the moon's year.

An orrery is said to have been constructed in the second century A. D. in China; the account states that it represented the apparent motion of the heavenly bodies round the earth, and was kept in motion by water dropping from a clepsydra.

The heliocentric, the true theory of our solar system, was taught in Ancient Egypt, and there Pythagoras learned it. This great philosopher perceived its truth, and carried it to Asia Minor, where it languished and died. The Egyptian race were originally emigrants from Asia, probably Arabians, and may have brought their astronomical knowledge with them. It is also possible that the Chaldees were participants in the true theory many ages before Greek explorers touched the borders of the Mesopotamian nations.

Eratosthenes of Cyrene, the Alexandrian astronomer, set on foot the first Hellenic measurement of an arc of the meridian, having its extremities at Alexandria and Syene, and for its object the approximate measurement of the earth's circumference. The measurement was the paces of pedestrians, but is interesting as among the earliest recorded instances of this broad generalization, where a philosopher rose from the consideration of the narrow limits of a single country to the knowledge of the magnitude of the entire globe. A more ancient Chaldean measurement is mentioned, the count being obtained in camels' paces, 4,000 paces to the mile, 33¼ miles to half a degree, — circumference of the earth. 24,000 miles. See *Comptes Rendus*, T. XXIII. p. 851, 1846.

Another measurement of a degree of the meridian was made under the orders of the Khalif Al-Mamun in the great plain of Sinds-char, between Tadmor and Rakka, by observers whose names have been preserved to us by Ebn Junis, tenth century.

"Each sage went for what he wanted to the proper mart of science: for not only Pythagoras studied astronomy at Heliopolis, where it was professed with the greatest *éclat;* but Eudoxus got his geometry at Memphis, whose priests were the most profound mathematicians; and Solon was instructed in civil wisdom at Sais, whose patron deity being Minerva (as we are told by Herodotus and Strabo), shows polities to have been there in most request." — WARBURTON'S "Divine Legation of Moses," Vol. I. Book II., ed. 1742.

The earliest observations in Babylon were 2234 B. C. Of their instruments we have no record: dials and zodiacal circles probably. The invention of the zodiac is by many experts credited to the Egyptians, and the reasons cited are entitled to high consideration. It is of high antiquity, and if pre-Egyptian was derived from the Orientals. Mazzaroth, cited in Job xxxviii. 31, 32, probably referred to zodiacal division.

One of the earliest instruments on record is that in the Memnonium, the great palace of Rameses II. It consisted of a golden zodiac or circle on which were engraved the days of the year, with the heliacal rising and setting of the stars by which each day was known. This golden planisphere was placed immediately over the sepulchre, upon a base 365 cubits (547½ feet) in circumference, or about 182 feet in diameter, and one cubit in thickness. It was divided and marked at every cubit with the days of the year, the rising and setting of the stars according to their natural revolutions, and the signs ascertained from them by Egyptian astrologers.

Rameses reigned in the fourteenth century B. C., — the century after the settling of the land of Canaan by Joshua and the century before the Argonautic Expedition. The golden circle was carried away by Cambyses when he plundered Egypt, 525 B. C., about the time of Kung-fu-tze (Confucius).

Ptolemy Euergetes, 246 B. C., placed in the square porch of the Alexandrian Museum an equinoctial and a solstitial armil, the graduated limbs of these instruments being divided into degrees and sixths. There were in the observatory stone structures, the precursors of our mural quadrants. On the floor a meridian line was drawn for the adjustment of the instruments. There were also astrolabes and dioptras. The above were used from 246 B. C. to A. D. 417, and similar instruments at Cordova, A. D. 1000. Tubes with sights were probably used at both places; lenses being added in 1608.

See articles under the following headings: —

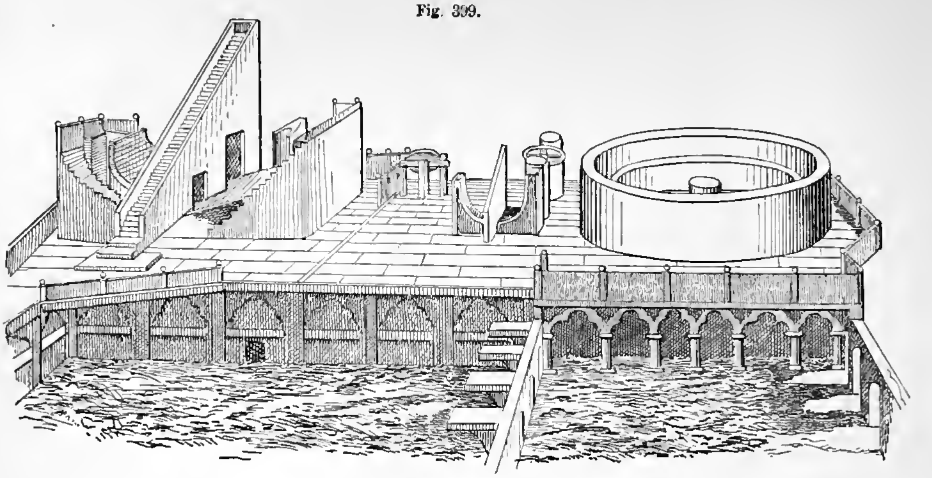
Altarimeter.	Finder.
Apomecometer.	Heliometer.
Armil.	Meridian Circle.
Armillary Sphere.	Micrometer.
Artificial Horizon.	Mural Circle.
Astrolabe.	Optical Instruments.
Astrometer.	Orbit-Sweeper.
Astroscope.	Orrery.
Azimuth Circle.	Planetarium.
Azimuth Dial.	Reflecting Circle.
Back-staff.	Refraction Circle.
Collimator.	Telescope.
Comet-Seeker.	Tellurian.
Compass.	Transit.
Cosmolabe.	Universal Instrument.
Dipleidoscope.	Zenith Sector.
Dip Sector.	Zenith Tube.
Equatorial Telescope.	

In Europe, the Arabs were the first to build observatories; the Giralda, or Tower of Seville, was erected under the superintendence of Geber the mathematician, about A. D. 1196, for that purpose. After the expulsion of the Moors it was turned into a belfry, the Spaniards not knowing what else to do with it. The same people mistook the vertical gnomons of Quito — beneath the line — for idols, and upset them, crossing themselves devoutly. Of the obelisks of Egypt, the round towers of Ireland, and the gnomons of Quito, the last is the least distinctly phallic.

The native observatory at Benares, India, is an elevated terrace, and will afford us a good idea of the probable appearance of the observatories of Ancient Chaldea; of the Caliph Almanza; of Uleg Beg, grandson of the great Tamerlane. The latter is said to have had a quadrant as high as the Church of Sancta Sophia at Constantinople.

Sir Robert Barker's description of the observatory

Fig. 399.



Native Observatory at Benares.

of Benares is as follows: "We entered this building, and went up a staircase to the top part of it near the river Ganges, that led to a large terrace, where to my surprise and satisfaction, I saw a number of instruments yet remaining in the best preservation, stupendously large, immovable from the spot, and built of stone, some of them being upwards of twenty feet in hight; and though they were said to have been erected many hundred years before, the graduations and divisions of the several arcs appeared as well cut and accurately divided as if they had been the performance of a modern artist. The execution in the construction of these instruments exhibited a mathematical exactness in the fixing, bearing, and fitting of the several parts, in the necessary and sufficient supports to the very large stones that compose them, and in joining and fastening them into each other by means of lead and iron cramps. The situation of the two large quadrants, whose radius is nine feet two inches, by being at right angles with a gnomon at twenty-five degrees elevation, are thrown into such an oblique situation as to render them the most difficult, not only to construct of such a magnitude, but to secure in the position for so long a period, and affords a striking instance of the ability of the architect in their construction; for, by the shadow of the gnomon thrown on the quadrants, they do not appear to have altered in the least from their original position; and so true is the line of the gnomon, that, by applying the eye to a small iron ring of an inch diameter at one end, the sight is carried through three others of the same dimensions, at the extremity of the other end, distant thirty-eight feet eight inches, without obstruction."

The earliest modern observatory of importance in Europe was erected by the landgrave of Hesse Cassel in 1561. It occupied the whole upper portion of his palace, and was well furnished with astronomical instruments. Tycho Brahe, about the same period, made material improvements on the landgrave's instruments, and constructed a quadrant capable of showing single minutes. He afterwards erected an observatory on the island of Huen, under the patronage of the king of Denmark; it was furnished with quadrants, sextants, circles, astrolabes, globes, clocks, and sun-dials. These instruments were divided to single minutes, and some were so divided as to read to ten seconds.

The royal observatory at Paris was completed in 1671, and was placed in charge of M. Cassini, after having been furnished with instruments at a very great expense.

The Greenwich Observatory was erected five years later; Flamstead, under the title of Astronomer Royal, was its first superintendent.

The Yale College Observatory was started in 1828, a donation made by Mr. Clark being expended in buying a telescope of Mr. Dollond of London. It has a focal length of ten feet, and five inches aperture.

The Williams College Observatory was the first regularly constituted observatory in the United States, 1836. It has a Herschelian reflector of ten feet focus, mounted equatorially; also a transit instrument and compensation-clock.

The Hudson Observatory of the Western Reserve College, Ohio, was built and furnished in 1838, having an equatorial, transit, and clock.

The High School Observatory of Philadelphia was furnished in 1840.

The West Point Observatory about 1841.

The Tuscaloosa Observatory in 1843.

The Washington Observatory about 1844.

The Georgetown, D. C., Observatory in 1844.

The Cincinnati Observatory in 1845.

The Cambridge Observatory in 1847.

The Amherst Observatory in 1847.

Dartmouth, Newark, Shelbyville, Ky., Buffalo, Michigan University, Albany, and Hamilton College, have also observatories.

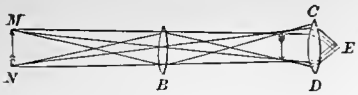
A good article on the astronomical observatories of the United States may be found in Harper's Magazine, June, 1856. See also "Observations at the Washington Observatory," volume for 1845.

For more full details than in the articles named, see Chambers's Astronomy; Dr. Pearson's Practical Astronomy; Loomis's Practical Astronomy; Simm's Treatise on Instruments; Heather on Mathematical Instruments.

As-tro-nom'i-cal Lan'tern. One with panes or slides having perforations whose relative size and position represent stars in a given field of the heavens.

As-tro-nom'i-cal Tel'e-scope. A telescope in which the image is inverted, composed of a converging object-glass $A\ B$, and of a converging eye-glass $C\ D$. Rays of light falling from any point M of a

Fig 400.



Astronomical Telescope.

distant object *M N*, and falling on the whole surface of the object-glass are refracted into the upper point in the principal focus. In like manner those proceeding from the point *N* are refracted into the lower point, and thus an inverted image is formed at the focus of the object-glass. The eye-glass is placed so that its focus shall coincide with the place of the image, consequently rays diverging from any point on the image, and falling on the lens *C D*, are rendered parallel and enter the eye at *E*, where they produce distinct vision.

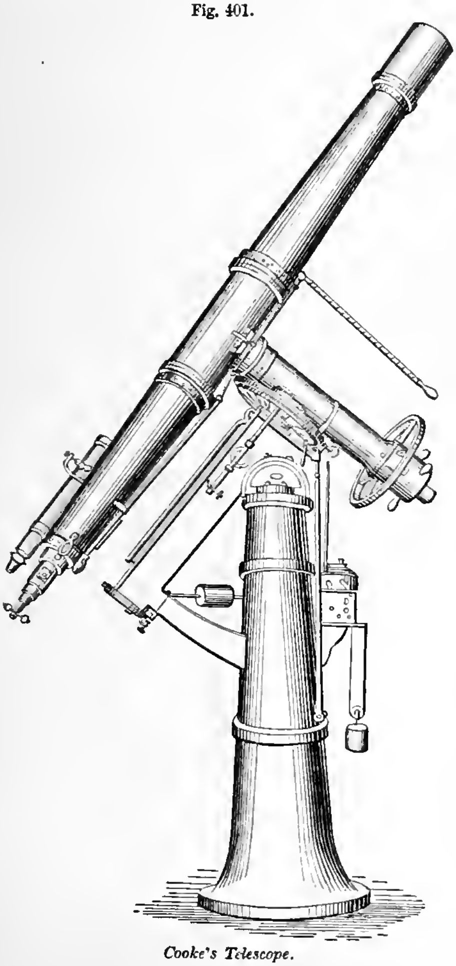
The length of the telescope is equal to the sum of the focal distances of the two lenses, and the magnifying power is equal to the focal length of the object-glass divided by the focal length of the eye-glass.

This telescope was first described by Kepler in his *Dioptrice*, 1611, but does not appear to have been executed till 20 or 30 years later.

A large instrument of its class was mounted at York, England, by Cooke. See Fig. 401.

It is mounted equatorially on the German principle, having a finder at the side, as is usual with that class of instruments. Sidereal motion is communicated to the instrument by clock-work. Its object-glass is 25 inches in diameter.

Fig. 401.



Cooke's Telescope.

The new refracting instrument for the Naval Observatory of Washington, D. C., is being made by Alvan Clark, of Cambridgeport, Mass., and will probably be completed during the present year (1873). Its object-glass is complete, and has a diameter of 27 inches. It is the largest of its class, and great hopes are reasonably entertained of its performances.

Large telescopes, equatorially mounted, are in the observatories of Cambridge, Eng., Cambridge, U. S., Chicago, Albany, Alleghany, and Pulkowa, Russia. The equatorial of Melbourne, Australia, is a reflector. See TELESCOPE.

As'tro-scope. 1. An astronomical instrument composed of two cones, on whose surfaces the constellations, with their stars, are delineated, and by means of which the stars may be known; an imperfect substitute for the celestial globe. — WEBSTER.

2. An astronomical instrument provided with telescopes, for observing the stars, invented and described by William Shukhard, of Tubingen, in 1698.

As-tyl'len. (*Mining.*) A small-dam in an adit or mine to prevent the full passage of the water.

At-a'bal. A Moorish musical instrument resembling a tabor. — CROLY.

At-a-rim'e-ter. A philosophical instrument used in a fixed observatory.

Ath'a-nor. The original *Base-Burning Furnace.* It was used by the old alchemists to ensure a constant supply of fuel to a furnace intended to keep up a continued heat for many consecutive days.

Alongside the furnace-chamber was a hollow tower containing charcoal, and fitted with a close cover to prevent the passage of air. The lower part communicated with the fireplace, and as the contents of the latter burned away, the fuel from the tower subsided into the fireplace and kept up the fire.

The subject has been amplified of late years. Watt introduced it into his steam-boiler furnace about 1767. Many stoves are now constructed on that principle in England and in the United States.

At what time the venerable alchemists first contrived the athanor we do not know. We presume that Hermes Trismegistus, Aristotle, and their colaborers of Egypt and Rome, may have done without it, but that it may have arisen when Roger Bacon, Albertus Magnus, Paracelsus, Raymond Lully, and Basil Valentine set about the search. This latter scope embraces several hundred years of valuable services.

The supply-chamber is termed a MAGAZINE (which see). See also SMOKE-CONSUMING FURNACE; STOVE, BASE-BURNING; COOKING-STOVE, BASE-BURNING.

At'las. 1. A size of drawing paper measuring 33 × 26 inches, and weighing 100 pounds to the ream.

2. The Indian satin of commerce.

3. (*Architecture.*) Plural, *Atlantes.* Male human figures serving as pillars; called also Telamones. The name is derived from an intended resemblance to Atlas or Ajax. A somewhat different style of figures, in which the attitude exhibits the appearance of less violent exertion, are called Persians.

Female figures employed for the like purpose are termed Caryatides.

At-mi-dom'e-ter. Babington's atmidometer for measuring the evaporation from water, ice, or snow, consists of an oblong hollow bulb of glass or copper, communicating by a contracted neck with a globular bulb beneath, weighted with mercury or shot. The upper bulb is surmounted by a glass or metallic stem graduated to grains and fractions, on the top of which is a light shallow metal pan.

For use, the instrument is placed in a vessel of water having a cover with a circular hole in it through which the stem protrudes.

Distilled water is poured into the pan on top until the zero on the stem is brought down to the level of the cover of the vessel in which the instrument floats. As the water in the pan evaporates the stem rises, and the amount of evaporation in grains and parts is indicated by the scale.

An adjustment for temperature accompanies the instrument. — BRANDE.

At-mom'e-ter. An instrument to measure vaporous exhalations. An *evaporometer* or *hygroscope*.

It was invented by Professor Leslie for determining the rate of evaporation from a humid surface in a given time.

A thin ball of porous earthenware, two or three inches in diameter, with a small neck, has cemented to it a long and rather wide tube of glass bearing divisions, each of them corresponding to an internal section equal to a film of liquid that would cover the outer surface of the ball to the thickness of one thousandth of an inch. The divisions are ascertained by calculation, and are numbered downward to the extent of 100 to 200. To the top of this tube is fitted a brass cap, having a collar of leather, and which, after the cavity has been filled with distilled water, is secured tightly. The outside of the ball being now wiped dry, the instrument is suspended out-of-doors to the free action of the air. The quantity of evaporation from a wet ball is the same as from a circle having twice the diameter of the sphere. In the atmometer the humidity transudes through the porous surface just as fast as it evaporates from the external surface, and this waste is measured by the descent of the water in the stem. As the process goes on, a corresponding portion of air is introduced into the ball and rises into the tube.

A modified form of the atmometer consists of a vessel of porous earthenware, having a given area of surface and filled with water, poised at the end of a balance, and the loss in a given time noted by weights on the other end.

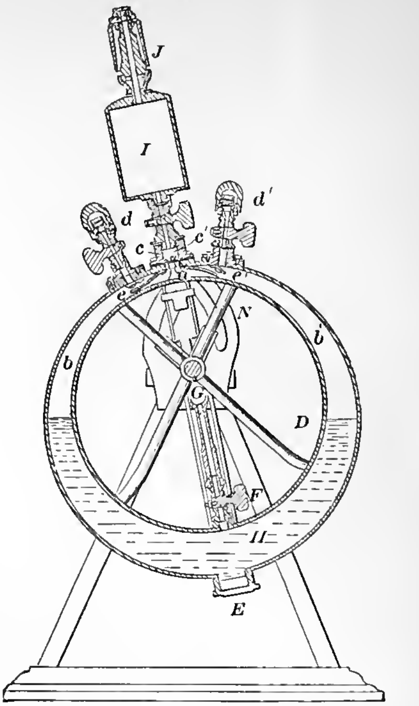
A thermometer inserted into the vessel will indicate the temperature of the evaporating liquid, and would form a *hygrometer* on the principle that the degree of cold generated by evaporation is proportional to the dryness of the air.

At-mos-pher-ic Alarm'-Whis'tle. A whistle blown by the air. It is principally used as a nautical alarm, being attached to a buoy, or placed on a pile or floating vessel, to warn ships from a shoal or spit of land. It is to be distinguished from audible alarms produced by clock-work or other machinery by which a blast of air is impelled through a whistle or horn. These are considered under FOG-ALARM; NAUTICAL ALARM; which see.

CABELL'S Atmospheric Alarm-Whistle, 1867, is sounded by the alternate eduction and induction of air from or into an annular chamber, which is partially filled with water and oscillated by the motion of the vessel, assisted by other power, if necessary. The motion may be made to work an air-pump to increase the energy of the blast, or its effectiveness may be augmented by gas, generated by chemical action in the chamber.

The chamber *D* has air-spaces *b b'* communicating by valves *c c'*, on either side of the dividing plate *a*, with the blast-whistle *J*. *d d'* are vacuum whistles, which act alternately as the chamber sways in one direction and the other, supplying air to that side of the chamber which is abandoned by the water. The funnel *G* is the means of supplying the chamber *D* with water. Oil upon the surface of the water in

Fig. 402.

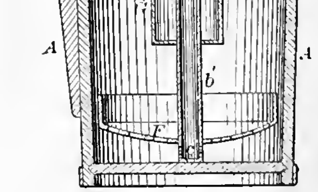


Cabell's Atmospheric Alarm-Whistle.

chambers *b b'* prevents evaporation. *e e'* are valves to the vacuum-whistle ports. *I* is an air-chamber.

At-mos-pher'ic Churn. A churn in which atmospheric air is driven into the milk in order to agitate it, and also to obtain the specific effect of the air upon the milk in aggregation of the oleaginous globules.

Fig. 403.



Atmospheric Churn.

There are many modes of doing this: —

1. The *air-pump*

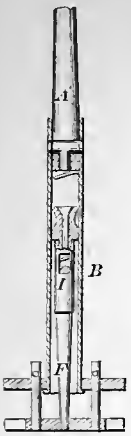
In this case the air is driven by mechanical means into and through the milk by means of a piston working in a cylinder, or by a bellows.

In the example (Fig. 403) the air is driven by the bellows *C* through the pipes *b b'*, passes out at *c*, and is distributed through the milk by the perforated diaphragm *F*. *G* is a vessel in which hot or cold water may be placed to temper the milk. The bellows-handle *E* is supported by a post on the churn *A*.

2. The centrifugal churn-dasher.

This is usually a vertical tube with radiating arms

Fig. 404.



Atmospheric Churn-Dasher.

at the bottom. As the tubular dasher is rotated, the air is expelled at the ends of the radial arms, a supply entering at the open upper end of the tube.

There are many modifications of this principle, but they all possess this substantive feature.

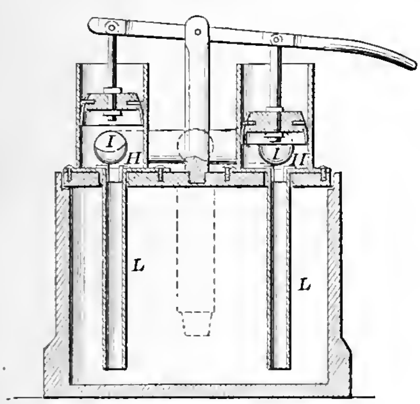
3. The reciprocating dasher.

In this case the tubular dasher has a valve which opens, on the upward motion, to admit air, and closes when the down stroke ejects the air from the tube into the milk.

In Fig. 404 the dasher is duplicated, the upper part being connected to the tubular shaft *B* and the lower part to the inner plunger *I F*. As the tube *B* rises, the plunger *I* descends, the valve *g* closes, and air enters at the upper valve-way in *A*. As the tube *B* descends, the upper valve closes, the plunger expels the air through the valve-way *a*, out at the bottom of the tube and into the cream.

In another form (Fig. 405) air at any desired temperature is forced into the churn at a point near the

Fig 405



Atmospheric Churn.

bottom by the reciprocating air-pumps, and has exit through the lid. As a piston rises, air enters beneath it by the valves *I* in the supply-pipe *H*. As the piston descends, the valve closes, and the air is delivered into the cream by the pipe *L*. The action of the pistons is alternate.

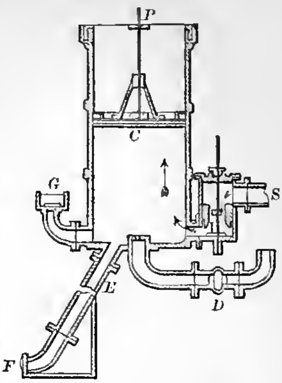
At-mos-pher'ic En'gine. Invented by Dr. Papin, of Blois, France, in 1695; improved by Newcomen, 1705, and Watt, 1769. It was the first good steam-engine on a working scale, and is the foundation of the Cornish engine. The present form of the engine has Watt's improvements.

In it the steam from the boiler is conducted beneath the piston, rather allowing it to rise than actually lifting it, as the weight of the pump-rod causes the pump-plunger to descend. The effective stroke is obtained by the condensation of the steam beneath the piston, when the pressure of the atmosphere on the latter lifts the pump-rod and the water.

In another application of the engine, the atmosphere raises the pump-rod, and the weight of the latter *forces* up the water.

The illustration shows the old atmospheric engine, in which water was injected into the cylinder itself for the purpose of condensing the steam below the piston, in order that the pressure of the atmosphere might be availed to force down the piston and make an effective stroke. The piston-rod *P* is connected to one end of the working-beam. The piston is shown as rising in the cylinder *C*, steam being admitted to it by pipe *S* and valve *V*. When the piston has attained its maximum hight, the valve *V* is closed, shutting off the steam, and the valve *D* is opened, admitting water at the injection-aperture. The water speedily condenses the steam, and the piston is depressed by the weight of the atmosphere.

Fig. 406.



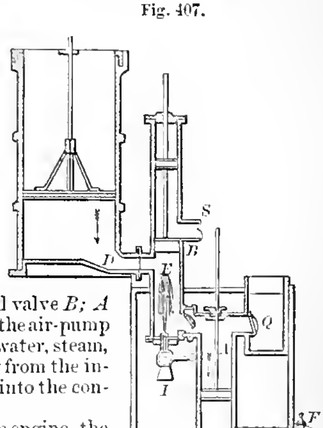
Newcomen's Atmospheric Engine.

The water escapes by the pipe *E* to the cistern called the *hot-well*, whence it is drawn for the supply of the boiler. The valve *F* opens outwardly to allow the water to escape. The air escapes by another pipe at the valve-way *G*.

The valves of this engine were originally in the form of faucets, which were turned by hand at the proper times, as we see in Worcester's, Papin's, and Savery's engines. The same plan was adopted in Newcomen's until an ingenious boy, Humphrey Potter, being placed in charge, devised in 1716 a means for connecting the lever-handles of the spigots to the working-beam, so that the motion of the latter was the means of opening and closing the respective valves at the proper times.

To the engine of Newcomen, Watt added, among other improvements, the separate condenser and the air-pump. By the former he avoided the cooling of the cylinder at each down stroke of the piston; by the latter he made the vacuum beneath the piston more perfect.

Fig. 407.



Watt's Atmospheric Engine.

In the improved form the steam is admitted by pipe *S* and valve *B*; *A* is the cylinder of the air-pump which ejects the water, steam, and air resulting from the injection of water into the condenser at *E*.

In starting the engine, the pistons of the cylinder and air-pump being both up, any accumulation of water at the bottom of the latter is drawn off by the faucet *F*, which is then closed. The valve *B* is then raised above the steam-pipe *S*, so as to fill the cylinder, condenser, and passage *D* with steam, which ejects the air at the valve Q. The slide B is then lowered, so as to shut off the supply of steam; the injection-faucet I is opened, discharging water into the condenser E, causing both pistons to descend. This is the effective stroke of the engine, and as the piston of the air-pump descends, the results of condensation, together with some steam and air, flow through the valve-way between the condenser and air-pump chamber, to be ejected, as the piston A rises, on the return stroke. The rising of the piston A closes the intermediate valve and opens the eduction-valve Q.

The latent heat of steam being about 950°, steam at 212° may be said to have 950° latent and 212° sensible heat, = 1162°. Steam mixed with $5\frac{1}{2}$ times its weight of water at 32° will raise the latter to *nearly* boiling heat, though the water requires a great increment of heat to raise it a few degrees more, as so much heat becomes latent in passing to the condition of steam.

The formula for construction of these engines is given as follows by Cresy.

The cylinder has a diameter equal to half its length.

The velocity in feet per minute should be 98 times the square root of the length of the stroke.

The stroke of the air-pump should be half that of the cylinder, and the diameter of the air-piston three eighths that of the steam-piston.

The area of the steam passage is: as 4800 is to the velocity in feet per minute, so is the area of the cylinder to the area of the steam passage.

To ascertain the quantity of steam, multiply the area of the cylinder in feet by half the velocity in feet; add one fifth for cooling. This result divided by 1480 gives the quantity of water required to supply the boiler.

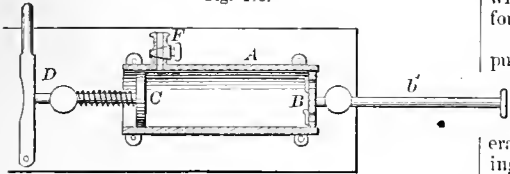
Twenty-four times this quantity of water is required for condensation.

The injection-aperture should be one thirty-sixth the diameter of the cylinder; the conducting-pipe one ninth.

To ascertain the power, multiply 6.25 times the square of the diameter of the cylinder in inches by half the velocity of the piston in feet per minute; the product expresses the effective power, or the number of pounds elevated one foot high per minute; the horse-power is found by dividing the result by 33,000.

At-mos-pher'ic Gov'ern-or. An apparatus for governing the motion of machinery by means of an imprisoned body of air subjected to pressure. The illustration shows one form of apparatus in which the brake-lever D may be brought into contact with some moving wheel of the machine to be regulated. The pressure of the air in the cylinder A upon the

Fig. 408.



Atmospheric Governor.

piston C is the measure of the power brought upon the brake D. This pressure may be decreased by allowing air to escape through the stop-cock F, or increased by the action of the valved piston B, b'.

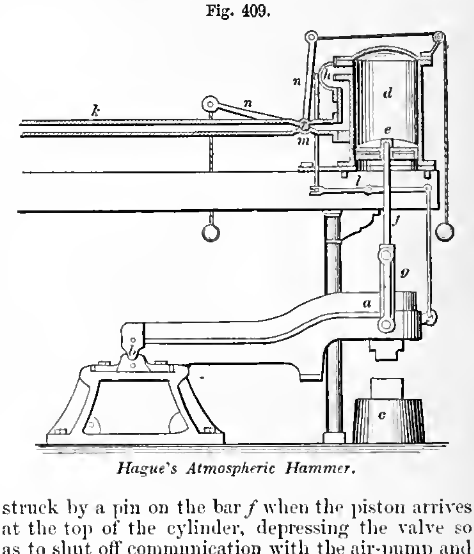
At-mos-pher'ic Ham'mer. A power-hammer driven by the force of compressed air.

In some cases the air is employed merely to lift the hammer; in other cases air is also employed as an adjunct in the effective stroke. In the latter case the operation is much like that of the steam-hammer, the main difference being in the substitution of air for steam.

In Hague's English patent some forty years since, an atmospheric hammer is shown, in which the helve is raised by the pressure of the atmosphere beneath a piston above the hammer-helve, the air being exhausted from above the piston by means of a pump; the hammer falling by its own weight when the air is admitted above the piston.

In Fig. 409, a b is the hammer turning upon the fulcrum at b; c the anvil; d a cylinder situated immediately over the hammer; e the piston connected with the hammer by the bar f and the slings g; h a slide-valve worked by the lever l, which is

Fig. 409.



Hague's Atmospheric Hammer.

struck by a pin on the bar f when the piston arrives at the top of the cylinder, depressing the valve so as to shut off communication with the air-pump and admit atmospheric air above the piston, permitting the hammer and piston to fall by their own weight.

Towards the close of the descent, the hammer, by means of a line attached to it and to the lever l, reverses the position of the latter and of the slide-valve, thus re-opening the communication between the cylinder and the air-pump. k is the pipe leading from the air-pump to the cylinder; m is a cock for shutting off the communication with the air-pump when the hammer is not at work; n n are spanners for opening and shutting the cock.

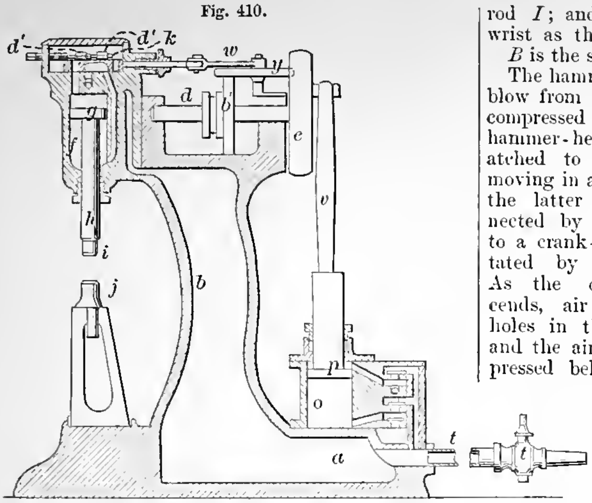
The atmospheric hammer (Fig. 410) has an air-pump and hammer combined in the same frame.

c is the band-wheel which derives its motion from the motor, — steam or water, as the case may be. v is the pitman, and p the piston operated by a wrist on the band-wheel c and condensing the air in the cylinder o. The compressed air is stored in a reservoir a b, and conducted to the valve-chamber.

In this chamber are a slide-valve k and stationary valve d' d', the former operated by the valve-rod w from the friction-wheels y d.

The head of the hammer h is attached to a piston g, which works in the cylinder f, into which air is admitted — like steam to a double-acting steam-engine — alternately above and below the piston. The friction-wheel b' is spline-keyed upon the shaft

Fig. 410.

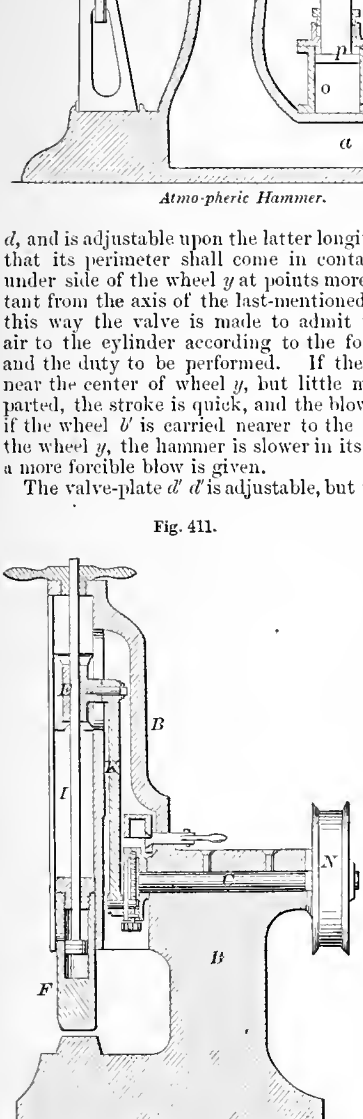


Atmo-pheric Hammer.

d, and is adjustable upon the latter longitudinally, so that its perimeter shall come in contact with the under side of the wheel *y* at points more or less distant from the axis of the last-mentioned wheel. In this way the valve is made to admit more or less air to the cylinder according to the force required and the duty to be performed. If the wheel *b′* be near the center of wheel *y*, but little motion is imparted, the stroke is quick, and the blow light; but if the wheel *b′* is carried nearer to the periphery of the wheel *y*, the hammer is slower in its motion, and a more forcible blow is given.

The valve-plate *d′ d′* is adjustable, but not involved in the active motions of the machine. Its adjustment affects the area of opening in the air induction-valve ports.

Fig. 411.



Atmospheric Hammer.

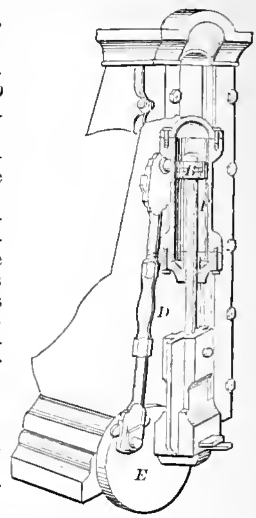
The stop-cock *t* is an escape for air when required. *i j* are hammer and anvil faces, respectively.

In another example (Fig. 411) the hammer is reciprocated by pitman connection *K* to a wrist on a crank-shaft *C*, operated by a band on wheel *N*. The hight of the hammer *F* above the anvil is graduated by the adjustment of its piston-rod *I*; and its stroke by the adjustment of the wrist as the crank-shaft.

B is the standard of the frame.

The hammer (Fig. 412) derives the decision of its blow from the force of compressed air. The hammer-head is atached to a piston *B* moving in a cylinder *F*, the latter being connected by a pitman *D* to a crank-wheel *E* rotated by the motor. As the cylinder ascends, air enters the holes in the cylinder, and the air being compressed below the piston, the hammer is lifted. As the cylinder descends, air is compressed above the piston, and is stored up to produce a sudden blow, by instant expansion after the crank and connecting-rod turn the bottom center.

Fig. 412.



Pneumatic Hammer.

At-mos-pher′ic Line. The equilibrium line of an indicator card, which shows that the steam pressure is equal to that of the atmosphere.

At-mos-pher′ic Pump. One in which the pressure of the air forces water into the pipe below the plunger. The usual form of *lift*-pump, though some lift-pumps elevate the water from immense depths in mines. The attempt in 1641 of a Florentine pump-maker to make an atmospheric pump which would elevate water 50 or 60 feet having failed, the Grand Duke asked Galileo to account for the failure. His reply was not to the purpose, but Torricelli ten years afterwards explained the cause. Galileo was by this time "in his grave." Malice had "done his worst . . . . nor steel nor poison" could "touch him further."

At-mos-pher′ic Rail′way. The idea of conveying carriages in a tube by means of atmospheric pressure seems to have originated with Dr. Papin, of Blois, in France, about the end of the seventeenth century. This extremely versatile man was the first to apply steam to raising a piston in a cylinder. He was the inventor of the Digester, and to this was first applied the lever-weighted safety-valve, also the Doctor's invention. The experiments actually entered upon by the philosopher of Blois, in the matter of compressed air, were principally directed to the transmission of power thereby. See Air as a Means of transmitting Power.

He placed air-compressing engines in positions where the compression could be effected by a fall of water, and pipes were to convey the air to the mine, where it was to be allowed to expand against a piston and work a pump. For some reason the project failed in its execution, but has been more successful in other hands.

The suggestion of conveying goods, parcels, and passengers by compressed air appears to have been rather a chance suggestion than to have been seriously entertained, and it has been again and again revived in the 130 years that intervened between Papin and Medhurst, who again urged the project about 1810.

Medhurst, in 1810, published an account of "a new method of conveying goods and letters by air," and in 1812 extended the idea so as to provide for the transmission of passengers, whom he proposed to transport at the rate of fifty miles per hour. His project consisted of an air-tight tube, containing a pair of cast-iron wheel-tracks on which the carriage has to run. The carriage had the form of the tube and a certain amount of packing to prevent the leakage of the air, which was condensed behind it and formed the propelling power.

His calculation was as follows: —

To obtain a speed of 50 miles per hour, in a tube six feet in diameter, would require a constant impelling force of 861 pounds moving at the rate of 73 feet per second, equal to the power of 180 horses. Taking the consumption of fuel of a steam-engine of that size at 12 bushels of coal per hour, three tons of goods might thus be conveyed 50 miles at a cost of 12*s.* and at the speed mentioned. The project fell upon the dead ear of the public.

Twelve years afterward the idea was revived in a changed form. Retaining the tube and carriage of Medhurst, Vallance, in 1824, obtained a patent in England for his modified plan, which consisted in using a partial vacuum in front of the carriage, allowing the natural atmospheric pressure in the rear to impel the carriage. In this he differed from Papin and Medhurst, who proposed a plenum in the rear, and not a vacuum in the advance.

Vallance's tunnel was to be of iron or vitrified clay, and he constructed a short tube in his garden at Brighton, which worked on the moderate scale on which it was applied, and was occasionally noticed in the journals of the day.

So far all the inventors have proposed that the carriage shall travel in the tube in the manner of a piston. The next proposition introduces a new feature.

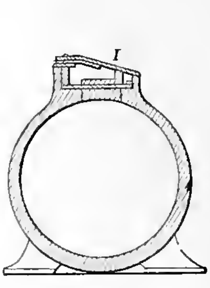
In 1834, Pinkus, an American citizen residing in England, took out a patent for an apparatus which he termed a Pneumatic Railway, and laid the foundation of most of the successful applications of the atmospheric principle which have since been introduced.

Pinkus's patent embraces a main with a continuous longitudinal slot on its upper surface, and an elastic gravitating valve to fill the slot. The tube was to be about forty inches in diameter, laid down between a pair of rails on which the carriages were to run, and having within it a piston attached by a vertical arm to the leading carriage of the train. The vertical arm passed through the slot in the upper part of the tube, and displaced the valve as the piston advanced, the valve closing in the rear of the arm after allowing some air to enter. The valve consisted of a thick cord saturated with a composition of wax and tallow.

Clegg patented some improvements in 1839.

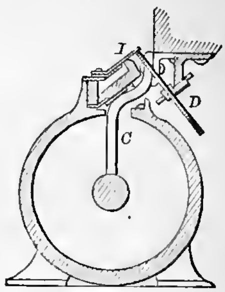
The valve works on a hinge of leather or other flexible material, which is practically air-tight, similar to the valves commonly used in air-pumps; the extremity or edge of the valve is caused to fall into a trough containing a composition of beeswax and tallow, or other substance which is solid at the temperature of the atmosphere, and becomes fluid when heated a few degrees above it.

Fig. 413.



Clegg's Valve closed.

Fig. 414.



Clegg's Valve open.

An outer flap of sheet-iron I covers the leather valve when the slot in the tube is closed behind the colter C, and is raised before the colter by the oblique roller D, Figs. 414, 415.

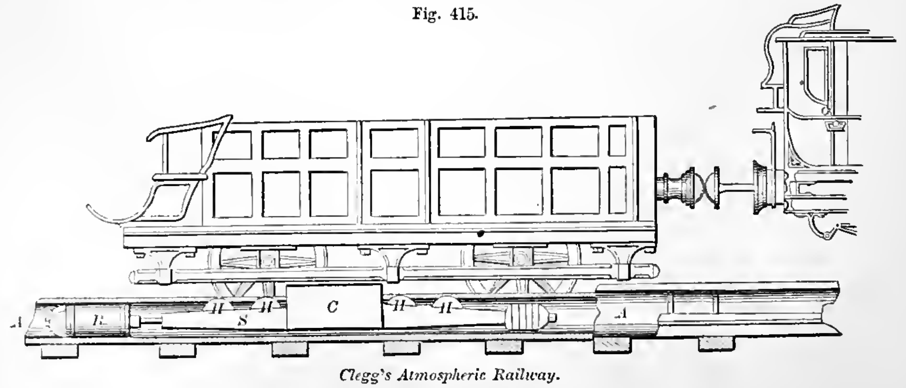
The tube A was coated inside with hard tallow, to make it perfectly smooth, and the piston B was furnished with a rod S, about 14 feet long, to which were attached rollers H H, which pressed open an air-tight valve along the top of the tube as the piston advanced. The piston was attached to the first, or driving, car by means of a colter C, and to the driving car was attached a copper vessel, several feet in length, heated with coke, for the purpose of melting the composition after the valve had been pressed down by the closing roller.

The valve behind the lifting-bar was held up for a sufficient time by the rollers H H, to allow the air to pass in behind the piston.

The pipe was divided by valves into three-mile sections, a steam-engine working the air-pump of each. The main was cast in sections nine feet long, joined by an oil cement.

An experimental line was laid down at Worm-

Fig. 415.



Clegg's Atmospheric Railway.

wood Scrubs by Clegg and Samuda. The line was half a mile long, with a rise of 1 in 120 for a part of the distance and 1 in 115 for the remainder. The diameter of the main was nine inches. The exhaustion was produced by means of an air-pump 37 inches in diameter and 22 inches stroke, worked by a condensing engine of 16-horse power.

This arrangement was employed from 1844 to 1855, on the line from Kingston to Dalkey, Ireland, $1\frac{3}{4}$ miles long. It is stated that an exhaustion of 15 inches could be produced in two minutes, and a rate of 50 to 60 miles an hour could be obtained. The rise is $71\frac{1}{2}$ feet in 3,050 yards.

The diameter of the main was 15 inches. The double-acting air-pump was $66\frac{1}{2}$ inches diameter, with a stroke of 66 inches. It was worked by a high-pressure condensing-engine of 34 inches diameter and 66 inches stroke, working expansively.

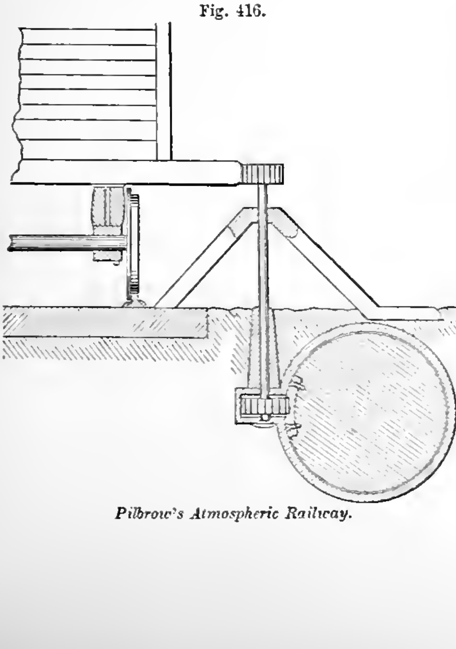
The stoppage was effected by a powerful brake, and, if necessary, by an arrangement operatable from the car, by which the valve was opened in advance, so as to destroy the vacuum.

Railroad engineers expressed very various opinions on the feasibility of the new project, Brunel and Stephenson took opposite sides, as usual, and the plan was tried in South Devonshire, on the Croydon Railway, and elsewhere. It eventually failed by reason of complexity and liability to get out of order, leakage of air impairing the vacuum.

The advantages are: facility in ascending heavy grades, rendering less cost necessary in leveling and grading; and security against collision.

Another form of conveying the motion of the piston in the atmospheric tube was invented by Pilbrow, and was intended to avoid the continuous opening in the tube, and the necessity for the valve which closed it on the Pinkus principle. Pilbrow made a toothed rack on the edge of his piston, which rack engaged with a series of pinions in air-tight boxes attached to the sides of the tube at short intervals. The vertical axes of these pinions passed upward through stuffing-boxes, and at the top were provided with other pinions which geared into racks on the sides of the carriages. Thus, the motion of the piston rotates the pinions successively as it advances along the line, and they communicate motion to the carriage. It is not known to the writer whether this device ever came into practical use.

Fig. 416.



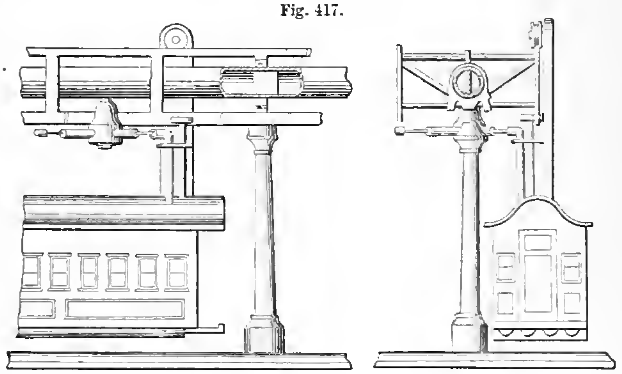
Pilbrow's Atmospheric Railway.

Keene and Nickel's Atmospheric Railway (English) was designed to act by compressed air in a tube laid along, under ground, between the lines of rail. Stationary above the surface are certain standards with grooved sides, in which are elastic pipes fed from the reservoir-pipe below. Beneath the carriage to be driven are rollers which are made to condense the elastic pipes into the hollowed sides, and the air, being admitted in the rear, expands against the peripheries of the drums beneath the carriage, and forces them to rotate and the carriage to advance.

Henry's Atmospheric Railway, English Patent, August 7, 1845, specifies a side slit in the atmospheric tube, and the longitudinal valve closed by the pressure of a long bag or hose, inflated with air and protected by a shield of wrought-iron bolted to the tube.

The vacuum in the tube is produced by first filling with water a number of large, close reservoirs connected with the tube by pipes and valves, opening the communication between the two, and then allowing the water to run off.

Fig. 417.



Elevated Railway.

The same mode of producing the vacuum was described in Aitken's English Patent, February 24, 1844.

In another application of the air, a tube laid throughout the line is filled with compressed air, and is used as a reservoir wherefrom compressed-air locomotives may renew their supply of air.

This is suggested in connection with one form of Elevated Railway.

In one form (Atmospheric Elevated Railway), the tube, which extends the whole length of the railway, is filled with compressed air, for the supply of the tanks on the cars, which form reservoirs for the supply of the air whereby the air-engines are driven. The tube at suitable intervals has valves and discharge-pipes for the supply of the engines on the cars.

The original proposition to use a transportation-tube and compression or exhaustion of air for the conveyance of lighter articles of freight and letters, has been put in practice successfully. A company was formed, and a permanent line laid down in 1859, for conveying parcels and light goods from the

Euston Square Station and the Post-Office in Eversholt Street, London, and an extension was opened in 1865.

This realizes the dreams of Papin and the hopes of Medhurst, nearly two hundred years after the busy speculations of the first and fifty years after the disappointment of the second.

A late act of Congress (1872) appropriates $ 15,000 for a pneumatic dispatch-tube between the Capitol and the Government Printing-Office, Washington.

The pneumatic dispatch-scheme has been put in operation at the Crystal Palace, Sydenham, England, to convey regular passengers.

The tube extends from the Sydenham entrance to the armory near Penge Gate, a distance of about a quarter of a mile; and it is, in fact, a simple brick tunnel, nine feet high and eight feet wide, — a size that renders it capable of containing an ordinary railway-carriage. The piston is rendered partially air-tight by the use of a fringe of bristles extending nearly to the brickwork of the tunnel and its floor. A fan 20 feet in diameter is employed to exhaust or to force in air, and perhaps it is impossible to devise any other expedient so well calculated to answer the required purpose. It must be remembered that either a plenum or a vacuum equivalent to .5 of an inch of mercury is quite sufficient to propel even a heavy train at a high speed on a moderately level line. In the present instance the motive-power is supplied by an old locomotive borrowed from one of the railway-companies, which is temporarily mounted on brickwork. The tires have been removed from the driving-wheels, and these last put the fan in motion by straps.

The line is a quarter of a mile long; a very small portion of it, if any, is level, but it has in it a gradient of one in fifteen, — an incline which no engineer would construct on an ordinary railway; and as it is not a level line, so it is not a straight one; for it has curves of only eight chains radius, which are shorter than those usually found in existing railways. The entire distance, 600 yards, is traversed in about 50 seconds, with an atmospheric pressure of but $2\frac{1}{2}$ ounces. The motion is, of course, easy and pleasant, and the ventilation ample, without being in any way excessive. See PNEUMATIC TUBULAR DISPATCH.

At-mos-pher'ic Spring. A spring formed by a confined body of air either operating by means of a cylinder and piston or by an air-tight bag.

It has been suggested for gun-carriages, to take the jar of the recoil, and also for railroad-cars. See PNEUMATIC SPRING.

A-tom'ic Weights. The appended list of chemical equivalents differs much from those of older and other authorities, but is offered as the best within the reach of the present writer. It differs also from a short list of chemical equivalents on page 66.

TABLE OF ATOMIC WEIGHTS.

Compiled according to the Latest Determinations, for the Use of the Students of the School of Mines, Columbia College, Jan., 1872.

BY C. F. CHANDLER, PH. D.

Hydrogen = 1.

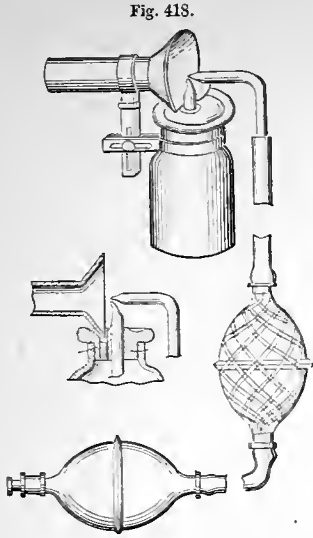
	SYMBOL.	OLD.	NEW.
Oxygen,	O.	8.	16.
Aluminium,	Al.	13.7	27.4
Antimony,	*Sb.*	122.	122.
Arsenic,	*As.*	75.	75.
Barium,	Ba.	68.5	137.
Bismuth,	*Bi.*	210.	210.
Boron,	*B.*	11.	11.
Bromine,	*Br.*	80.	80.
Cadmium,	Cd.	56.	112.
Cæsium,	*Cs.*	133.	133.
Calcium,	Ca.	20.	40.
Carbon,	C.	6.	12.
Cerium,	Ce.	45.7	91.3
Chlorine,	*Cl.*	35.5	35.5
Chromium,	Cr.	26.1	52.2
Cobalt,	Co.	30.	60.
Columbium,	*Cb.*	94.	94.
Copper,	Cu.	31.7	63.4
Didymium,	D.	47.5	95.
Erbium,	E.	56.3	112.6
Fluorine,	*F.*	19.	19.
Glucinum,	Gl.	4.6	9.2
Gold,	*Au.*	197.	197.
Hydrogen,	*H.*	1.	1.
Indium,	In.	56.7	113.4
Iodine,	*I.*	127.	127.
Iridium,	Ir.	99.	198.
Iron,	Fe.	28.	56.
Lanthanum,	La.	46.	92.
Lead,	Pb.	103.5	207.
Lithium,	*Li.*	7.	7.
Magnesium,	Mg.	12.	24.
Manganese,	Mn.	27.5	55.
Mercury,	Hg.	100.	200.
Molybdenum,	Mo.	48.	96.
Nickel,	Ni.	29.	58.
Nitrogen,	*N.*	14.	14.
Osmium,	Os.	100.	200.
Oxygen,	O.	8.	16.
Palladium,	Pd.	53.	106.
Phosphorus,	*P.*	31.	31.
Platinum,	Pt.	98.7	197.4
Potassium,	*K.*	39.1	39.1
Rhodium,	Ro.	52.	104.
Rubidium,	*Rb.*	85.4	85.4
Ruthenium,	Ru.	52.	104.
Selenium,	Se.	39.5	79.
Silicon,	Si.	14.	28.
Silver,	*Ag.*	108.	108.
Sodium,	*Na.*	23.	23.
Strontium,	Sr.	44.	88.
Sulphur,	S.	16.	32.
Tantalum,	*Ta.*	182.	182.
Tellurium,	Te.	64.	128.
Terbium,	Tb.	37.7	75.4
Thallium,	*Tl.*	204.	204.
Thorium,	Th.	59.2	118.4
Tin,	Sn.	59.	118.
Titanium,	Ti.	25.	50.
Tungsten,	W.	92.	184.
Uranium,	U.	60.	120.
Vanadium,	*V.*	51.3	51.3
Yttrium,	Y.	30.8	61.6
Zinc,	Zn.	32.5	65.
Zirconium,	Zr.	44.8	89.6

At'om-i-zer. The atomizer is designed to reduce a liquid into spray for disinfecting, cooling, or perfuming purposes.

Several different modes of operation are adopted. One style consists of a blast of air presented at right angles across an opening in the end of a tube which communicates with a supply of the liquid. This acts somewhat on the principle of the Giffard Injector, raises the liquid, and by contact disperses it, reducing it to a fine spray. The contiguous air and fluid tubes are connected to the vertical or cup tube, so as to be reversible in relation thereto.

The atomizer-tube is used to diffuse a cooled liquid in spray to render it more effective in absorbing the sensible heat of a room or vessel. There are

Fig. 418.



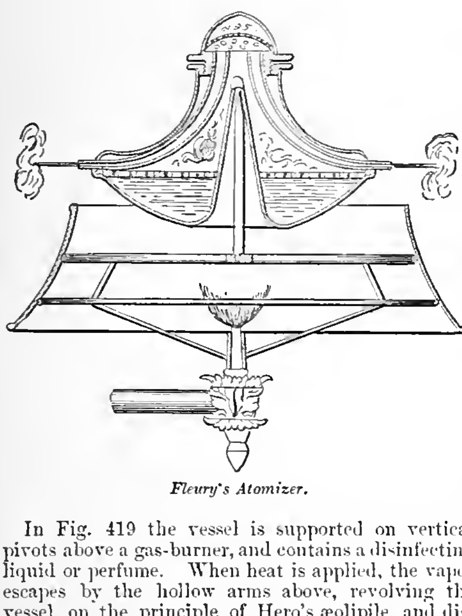
Atomizer.

many adaptations to boats, granaries, hospitals, fruit-chambers, and for making ice.

In the atomizer (Fig. 418) the atomizing blast is ejected by an elastic bulb, and crosses the orifice of the tube leading from the vessel of liquid, whose contents are thereby raised, and driven, in the form of spray, through the shield, which directs it upon the part where local anæsthesia is required. The shield has a flaring and cylindrical portion, is hinged to the liquid vessel, and adjustable in relation thereto, and drains into the vessel.

In another apparatus for impregnating the air with antiseptic vapors, to prevent infection and purify the atmosphere of hospitals, etc., a trough holds the antiseptic liquid, such as tar, carbolic acid, turpentine, etc., from which the vapors are to be generated. A frame contains a number of vertical perforated plates, which, after dipping in the liquid, are supported in a raised position, so as to part with their vapors to the atmosphere.

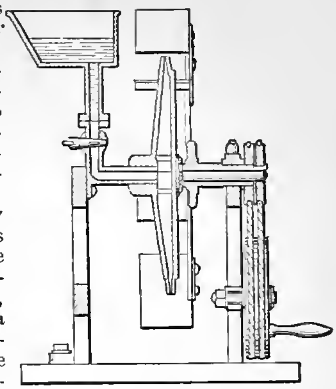
Fig. 419.



Fleury's Atomizer.

In Fig. 419 the vessel is supported on vertical pivots above a gas-burner, and contains a disinfecting liquid or perfume. When heat is applied, the vapor escapes by the hollow arms above, revolving the vessel, on the principle of Hero's æolipile, and disseminating steam and spray in the apartment. The apparatus is supported upon a pivot erected upon the frame of the shade, which is secured to the gas-burner in the usual manner. The atomizer is also used in connection with an air-carbureting apparatus.

Fig. 420.

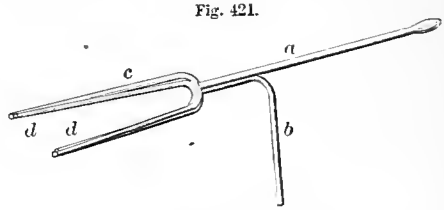


Atomizing Wheel.

In the early and simple forms of inhalers the liquid was vaporized by heat, and this is a desirable condition for some modes of treatment. In many cases, however, the increased temperature produces injurious effects. A means of changing the liquid into mist, which does not act on the Giffard principle, as in the modern form of atomizer, is shown in Fig. 420. The rotary wheel has hollow, radial arms, terminating in very small orifices, through which the liquid is thrown in jets by centrifugal action. The liquid is ejected against oblique plates attached to the ends of the radial arms of another wheel which rotates in a direction the reverse of the former. The contact of the liquid with the plates reduces it to a spray, which pervades the chamber in which the operation is carried on, and the patient is caused to breathe the mist either by a tube or otherwise.

In the anæsthetic instrument for dental purposes, each tube is bifurcated, so as to reach the inner and outer sides of the jaw simultaneously, by the branches *d d*. The straight tube *a* carries the air-blast,

Fig. 421.



Cutter's Atomizer.

and thus draws a current of liquid whose rapid evaporation produces cold and local anæsthesia. The lower end of the bent tube *b* is dipped in the liquid, and it discharges at its end, while the air-tube *a c* discharges just in advance of it, producing a spray of the liquid.

The atomizer is adapted for operation by hand or foot bellows (see Fig. 181). It consists of a hollow curved tube, made of German-silver, one extremity of which has an adjustable conical cap, while the other passes down into the bottle through a perforation in the cork. A short distance above the cork this tube has another tube joined to it at right angles, and which is attached to the india-rubber tubing. Within the second tube there is contained a capillary one, which extends from within a line or two of the extremity of the cap nearly to the bottom of the bottle, and beyond the bottled extremity of the larger tube. Near its upper extremity this capillary tube perforates a cylinder of metal, which almost completely occupies the caliber of the larger tube, and would entirely plug it up except that it has longitudinal grooves upon its surface. Pressure upon the hand-ball forces air through the other ball, and so to the cavity of the curved tube. One column of this air passes upward through the tube, and the other downward into the bottle. The upward column passes through the grooves in the circumference of the plug into the cavity of the cap, and escapes through the capillary orifice at its tip. This column of air, passing over the extremity of the capillary tube, creates a vacuum in it, which is supplied by the liquid contents of the bottle, upon which one of the columns of air is pressing. The other column of air divides into spray the drops as they issue from the inner tube.

The theaters of the Romans were fitted up with numerous concealed pipes, that passed in every direction along the walls, and were connected to cisterns of water or to machines for raising the latter. Certain parts of the pipes were very minutely perforated, and were so arranged that, by turning one or more cocks, the liquid escaped from them, and descended upon the audience in the form of dew or extremely fine rain. This effectually cooled the heated air, and must have been exceedingly refreshing to the immense multitudes, especially in such a climate as Italy.

"The dining-rooms of Nero's golden house were ceiled in such a manner that the attendants could make it rain either flowers or liquid perfumes. At one feast 100,000 crowns were expended in perfumed waters." — EWBANK'S *Hydraulics*.

It is possible that the Romans extinguished flames in the same manner. See also Sir William Congreve's English patents Nos. 3201, 3606; 1809 and 1812.

At-tached' Col'umn. (*Architecture.*) One partially imbedded in a wall. An *inserted* column.

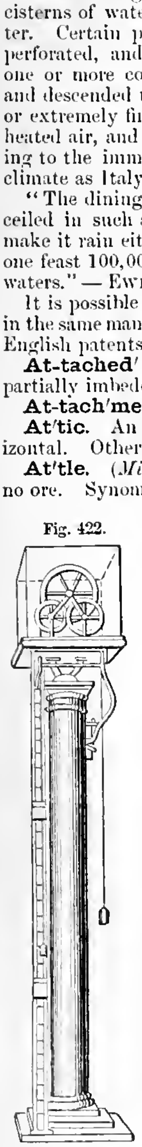
At-tach'ment Screw. A binding screw.

At'tic. An upper story, when the ceiling is horizontal. Otherwise it is a *garret*.

At'tle. (*Mining.*) Rubbish containing little or no ore. Synonyms: *addle; adill; attal.*

At'wood's Ma-chine'. A scientific apparatus to illustrate the theory of accelerated motion.

Fig. 422.



Atwood's Machine.

It consists of a wooden column, about 10 feet high, resting on a base and supporting a series of anti-friction wheels, which support a large central roller, over which passes a cord having equal weights at each end, so as to be *in equilibrio*. By means of a graduated staff at one side the rise of one and fall of the other weight are indicated in feet and inches.

A small additional weight, being added to one of the large weights, causes it to descend with a velocity due to its excess of gravity over the other; and this being very small, the motion is correspondingly slow, rendering the resistance of the air inappreciable, and enabling the rate of descent to be ascertained with great accuracy.

The counterpoise weights of this apparatus enable the constant acceleration of speed caused by gravity in a falling body to be shown and measured within the space of a few feet more accurately and satisfactorily than could be done by the fall of a weight not thus counterpoised from a considerable hight.

It may also be employed to illustrate the laws of retarded motion, impact of bodies, and resistance of fluids, as well as other phenomena of a similar nature.

Alhazen the Saracen, A. D. 1100, in his "Book of the Balance of Wisdom," considered the subject of gravity, and asserted that it diminished with the distance. It was reserved for Newton to determine that it decreased as the square of the distance. Alhazen determined correctly the relation between the velocities, spaces, and times of falling bodies. The University of Cordova was the intellectual center of Europe in his day. The Khalif Alkamen's library was so large that its catalogue filled 40 volumes. The people of Cordova could walk paved streets at night 10 miles in a straight line, by the light of public lamps, when London and Paris were dark and dismal mud-holes.

Galileo, born 1564, considered the subject of acceleration of force, and determined the relation between the spaces of descent and the times. He used inclined planes, by the aid of which he conveniently diminished the velocity without changing the nature of the result.

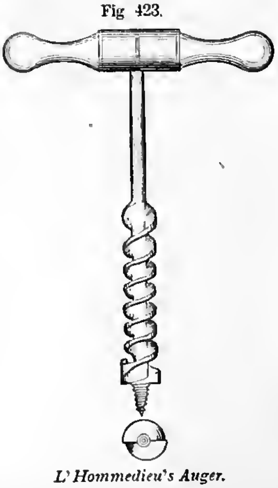
Au'ger. The first boring-tool may be assumed to have been an awl of some kind. Pliny states that Dædalus invented the gimlet, — 1240 B. C. It was destitute of a screw-point, but it may have had a hollow pod, and a cross-head forming a handle. Awls are shown in Egyptian tombs of 1706 and 1490 B. C. The screw-point was added to the gimlet in course of time, and, within our own recollection, the twisted shank, which makes it self-discharging. This hint was taken from the auger proper, which may be called a magnified gimlet, now that their specific features have become so closely assimilated in form and function. The auger (*terebra*) was a Greek tool.

The *Teredo navalis* is much older still, and carries an auger in his head; — a great bore he is.

From the early descriptions, the auger appears to have been considered a shipwright's tool. It formerly had a curved, sharpened end, and a concavity to hold the chips; this was a *pod* auger. To this a lip was subsequently added for some kinds of boring, and in course of time the depression grew into a spiral, which allows the chips to escape while the boring proceeds, instead of withdrawing the tool as the pod becomes filled.

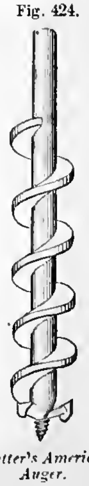
The *Twisted Auger* is an American invention, and was made by Lilley, of Mansfield, Connecticut, about the beginning of the present century, and afterwards by Gurley, of the same place.

Fig 423.



L'Hommedieu's Auger.

Fig. 424.



Shetter's American Auger.

Fig. 425.

Cook's Auger.

Augers may be classified as augers; hollow augers; annular augers; taper augers; augers with secondary borers, reamers, or countersinks, or having expansive cutters. Auger-gages, auger-handles, and machines for making augers, will be considered separately.

L'HOMMEDIEU'S *Auger*, 1809 (Fig. 423), has two pods, two cutting-lips, a central screw, and a twisted shank. It is hardly fair to say that it is perfect of its kind, as so many improvements have followed; but it is, on a smaller scale, like Stephenson's "Rocket" Engine, the type of its class. The form of auger which in England is called the "American" pattern was patented by SHETTER, March 21, 1831. It has a spiral blade around a cylindrical core, and was long a favorite. The "good workmen" who "never quarrel with their tools" do not seem to have retained this form in the estimation it once held. It probably offers more impediment to the discharge of the chips than does the shank made from a flat blade twisted into a spiral. Some auger-shanks have an *increase twist* as they recede from the point; this gives a greater freedom of discharge by increasing the caliber of the canal as the chips ascend.

Fig. 426.

Kasson's Auger.

In the auger (Fig. 425) the cutting-lips commence at the screw or point, and extend therefrom nearly at right angles, until about half-way from the center to the outer point, and then curve upward and forward, giving a nearly semicircular form to the outer portion of the lips, which are curved in the horizontal and vertical planes.

The auger (Fig. 426) permits the formation of cutting-lips at any point on the length of the spiral, by cutting off the twist at any point, in a plane vertical, or nearly so, to the axis of the auger, and then sharpening its edges. The front surfaces of the twist are concave, and the rear convex.

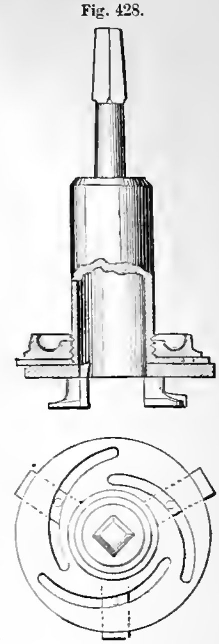
The *Slotting Auger* cuts laterally, the work being fed against its side. It is used in wood-mortising and slotting machines. The twist is formed into a number of chisel-shaped lips rising from the edge of the twist and presenting sharp edges in the direction of the bore of the auger, so that the wood may be cut laterally if pushed against the instrument after the hole has been bored to a sufficient depth for the proposed mortise or slot. The end-lips may be made chisel-shaped or hollow like a gouge, as desired. If the auger or bit be held in the rapidly revolving arbor of a mortising or boring machine, the mortise may be cut at full depth, at one operation, by moving the wood laterally against the auger. The corners of the mortise are afterwards cut out by a chisel.

Fig. 427.

Slotting Auger.

Hollow Augers are used for forming tenons on the ends of spokes, bedstead-rails, chair rounds and legs, table-legs, and many other articles. Those on a more extended scale, which allow the material to pass clear through them, are properly turning-machines, and are adapted for making scythe-snaths, broom-handles, etc.

Fig. 428.



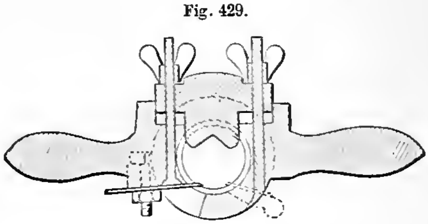
Hollow Auger.

The hollow auger, as a tool, operates to a certain length on the object, after which the auger or the object is withdrawn. Means for measuring the stroke are frequently found in the construction of the tool, as by the depth of the socket; but other means may be used, and are known as *auger-gages*.

This tool (Fig. 428) is adjustable for boring holes of different sizes. The rotary disk has eccentric slots acting upon pins inserted into the backs of sliding cutter-heads, so that they are driven out or drawn in simultaneously, and fastened by a jam-nut, which holds them in the required adjustment. The above is adapted to be used as a bit in a brace.

Fig. 429 has cross-handles like an auger. The cutting-tool is so attached as to project within the opening, and the size of the tenon is regulated by the adjustment of the angular rest. The tool has the usual auger-handles, in which respect it differs from most of its class. They are usually attached to braces or to mandrels rotated in bearings similar to those of the lathe-head.

Fig. 429.



Hollow Auger.

A dozen others might be cited, but these are probably sufficiently descriptive.

Fig. 430.

Annular Auger.

Annular Augers cut an annular groove, leaving "land" on the inside *and outside* of the channel. The example (Fig. 430) is adapted for boring cylindrical blocks out of a board, the lower edge of the tube being serrated. Fitted inside the tube is a cylindrical plug with a central point. On the reduced shank of the plug is a spiral spring, which keeps the point extended, except when pressure is applied to the tool in boring.

The cutters on the end of the tube (Fig. 431) make an annular groove and leave a core of wood in the center, the chips being withdrawn continuously by the spiral blade on the tube. The cutting-lips start at the periphery of the bit, and extend towards the center in concave lines, till they terminate at the inner portion of the tube, where their direction approaches a line parallel with the axis of the auger. In a subsequent form a number of tubes are arranged concentrically, so as to cut concentric, annular grooves sim-

Fig. 431

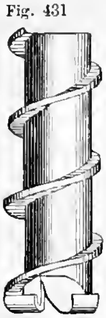
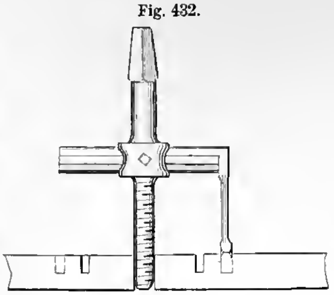
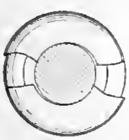


Fig. 432.



Annular Borer.

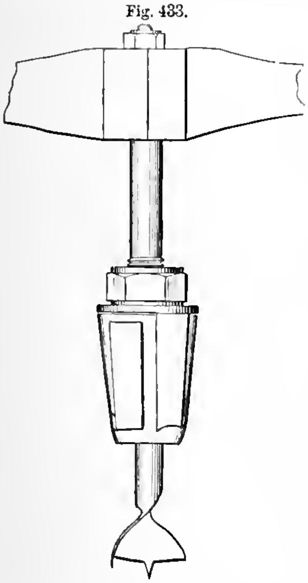


Annular Auger.

ultaneously, and produce a nest of cylinders out of the same stick or board.

Yet another form is found in the tool (Fig. 432) sometimes known as a button-tool. It has an upright center standard, with a fine feeding-screw on the lower end. The cutter is attached to a radial arm, and is adjustable, so as to describe the diameter required for the hole. The cutter is fed to its work by the thread on the standard, and the chips are ejected by the curved neck.

Fig. 433.



Kirby's Taper Auger.

Taper Augers are used for reaming out bungholes, making butter-prints, etc. The center bit bores a hole, and is succeeded by the taper reamer, which has a throat for the chips, cut through from the edge of the bit on one side to the opposite side of the stock.

The *Bunghole Reamer* (Fig. 434) has a tapering pod, and a cutting-lip on one side; the lower end is closed to receive the chips, and is open at the top, except a bail to which the handle is fastened. On one side is an adjustable gage and index to determine the size of the bore.

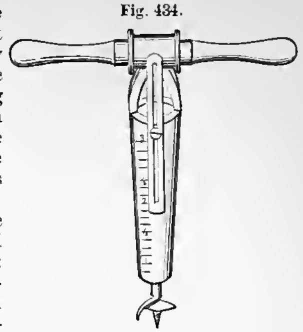
The ordinary form of bunghole borer is shown in Fig. 435. This has a volute-shaped blade with a sharpened, salient spiral edge and a gimlet point. It, like most of its class, is for reaming out bungholes and taps.

Augers are sometimes provided with secondary borers, reamers, countersinkers, or expansive cutters.

In Fig. 436 the reamer or secondary borer is formed in two pieces, and is clamped to the auger-shank at the required distance from the end of the tool, and at the same time is adjustable to ream out a hole of the required diameter. The clamp is shown separately in the upper portion of the figure.

In Fig. 437 the countersink is attached to the auger-shank at the required spot, but does not entirely surround the shank, the opening corresponding with the twist of the shank, so that the discharge of chips is not interrupted.

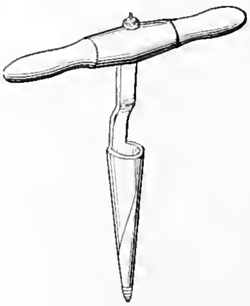
Fig. 434.



Bunghole Reamer.

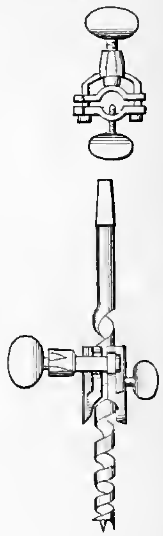
In Fig. 438 the plate is received into a longitudinal slot in the auger-shaft, and one end is secured by a temper-screw. A pin, passed through one in the series of holes in the shaft, engages a hole in the oblique series in the plate, and determines

Fig. 435.



Crocker's Taper Auger.

Fig. 436.



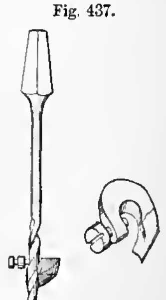
Counter-Borer.

the radial adjustment and consequently the diameter of hole bored by it.

The shanks and turned cutting-edges of the expanding bits in Fig. 439 pass through a mortise in the head of the tool, and are secured to their adjustment by a key. Their radial adjustment adapts them to bore holes of varying sizes.

In Fig. 440 the cutter is adjustable eccentrically, and is held by a dovetailed groove and tenon. The cylindrical core is solid, and the center point is removable. The spiral has a sharp edge. The adjustment of the cutter on its eccentric pivot varies its radial sweep in boring, and it is thereby adapted to bore a hole of the required size, within the limit of its capacity.

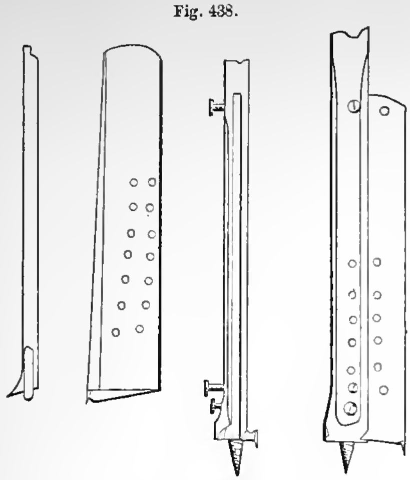
Fig. 437.



Countersink.

Among the other uses of augers may be mentioned that of felling trees in the Mammoth Grove, Calaveras County, California. This grove is in a gently sloping valley, heavily timbered, situated on the divide or ridge between the San Antonio branch of the Stanislaus River, in latitude 38° north and longitude 120° 10′ west, and 5,200 feet above the level of the sea; here, within an area of about eighty acres, and high above the surrounding trees of the forest, can be seen

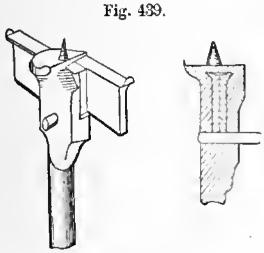
Fig. 438.



Expanding Auger.

the stately heads of these evergreen forest giants, the *Sequoia gigantea*. These trees are now growing in many parts of Great Britain and France, from California cones or burs, and no native trees are equal to them in the rapidity of their growth.

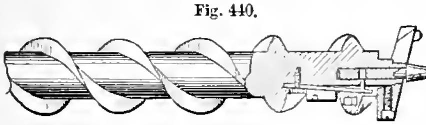
Fig. 439.



Expansible Auger.

There are twenty of these trees that will average 25 feet in diameter at the base. One of the largest now standing is called the "Mother of the Forest," and has been stripped of its bark 116 feet high, and still measures in circumference at the base 84

Fig. 440.



Expansible Anger.

feet; 20 feet from the base, 69 feet; 70 feet from the base, 43 feet 6 inches; 116 feet from the base, 39 feet 6 inches; circumference at the base, including bark, 90 feet. Its hight is 310 feet, and it is supposed to be 3,000 years old; the average thickness of the bark is 11 inches, but in some of the trees it is as much as 22½ inches.

The "Big Tree," as it was called, contained 500,000 feet of inch lumber. It was felled by five men working 22½ days, making 112½ days' labor to fell one tree. This tree measured 92 feet in circumference at the base. It was not cut down with axes, but was bored down with long pump-augers, and the wood remaining between the holes was cut off with chisels on the end of long sticks. A building, in which was a telegraph-office, was erected on the stump, which served as a floor, having been hewn off smooth. A bowling-alley was also built on the remainder of the tree, after a large part of it had been worked up into canes and sold.

The body of the "Father of the Forest" which lies half buried in the earth, measures 110 feet in circumference at the base, and 200 feet in length to the first branch, and, being hollow, a person can walk that length erect. The estimated hight of this tree when standing is 400 feet. The "Burned Tree," prostrate also, is hollow 60 feet, and persons can ride on horseback through it for that distance; it is 97 feet in circumference, and was 330 feet high. There are several other trees of immense size, and variously named.

Au'ger-bit. A boring-bit with a twisted shank, which clears the chips out of the hole.

An auger of a size adapted to be set in a brace or stock, to be revolved thereby.

Au'ger, Earth-bor'ing. A tool for boring holes in earth which is not too compact. There are quite a number of these, varying in detail, but possessing the same general characteristics. The ordinary kind (Fig. 441) has a nearly circular disk, with a lip projecting downward, to scrape up the earth which accumulates above the blade as the latter is rotated. The blade is occasionally raised to the surface to dump its load.

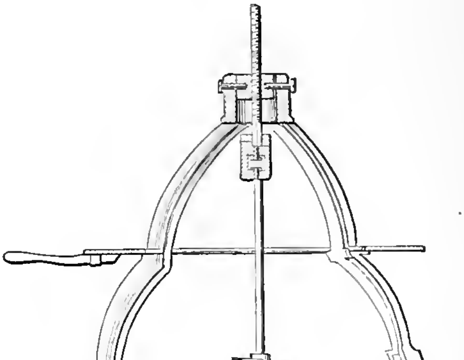
Fig. 441.

Post-Hole Auger.

This raising to dump the load is a general characteristic of post-hole augers, and renders the operation somewhat tedious. The delay has induced arrangements for enabling the tool to hold a large amount of earth, and attempts to make its discharge continuous.

In Fig. 442 the shaft has a point, cutting-lips, and a floor on which the earth is received. It is forced into the ground by the screw on the shank, which rotates in a nut at the junction of the legs of

Fig. 442.

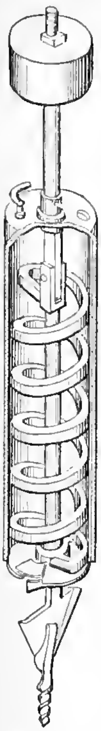


Earth-boring Auger.

the tripod, which is raised above the spot where the auger enters. The end of the screw-shaft is keyed to a stirrup, in which it turns. Above the stirrup is a coupling-piece, having inclined projections fitting in corresponding recesses in the upper part of the stirrup in such a manner that the shaft is made to operate the screw when boring a hole in the ground, and a reverse motion of the shaft will raise the screw out of the ground without turning it.

In Fig. 443 the shaft has a screw point and angular wings, above which is the floor of the dirt-chamber. The soil is scooped up by the usual flange, and is elevated in the chamber by the spiral,

Fig. 443.



McMahen's Earth-boring Auger.

which is braced by the axial rod. The cylindrical case is the measure of its capacity in withdrawing a load.

Other inventions might be cited, but the above represent all the varieties excepting minor differences.

All these are worked by hand, and remove the soil by lifting the tool at intervals from the hole and discharging it. This may be considered the normal character of a post-hole auger.

There are numerous devices for penetrating the ground where the apparatus acts to disintegrate the matter with which it comes in contact: these are called DRILLS, DRIVEN WELL-TUBES, WELL-BORERS, etc., and may be found described under other heads.

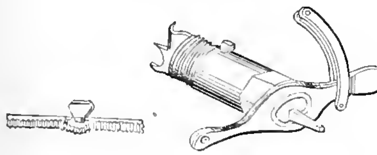
The first is either jarred or rotated to grind its way through soil and rock, and is associated with devices for lifting the detritus by sand-pump, by a stream of water, or by the upward force derived from the concussion of the drill with the rock.

The second consists of a tube which is driven or screwed into the earth, and is generally intended to remain as the permanent pump-tube; for this purpose it has a solid point, to withstand the contact of the obstacles which it is expected to pierce or displace, and holes which are unclosed to admit the water after the wet stratum is reached; these will be explained under their appropriate heading.

The third are devices of a more extensive character than mere hole-diggers, and are used in sinking *Artesian wells*, oil and salt wells, and in boring for mineral lodes.

Au'ger-fau'cet. A faucet with an attached auger, by which the necessary hole is made in the head of the cask. As soon as the auger has about penetrated the

Fig. 444.

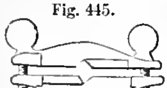


Auger-Faucet.

stave, a blow is given to the auger, which breaks away the scale of wood, and the same blow settles the auger into its position. The bit is attached to the faucet, and is projected or retracted by a rack on its shank within the faucet, actuated by a thumb-screw. A frustal projection on the cap affords means for operating the device by a brace.

Au'ger-gage. A device to be attached to the shank of an auger to limit the penetration. The countersinks of some of the compound augers and the sockets of the hollow augers effect the same purpose in some cases.

Fig. 445.

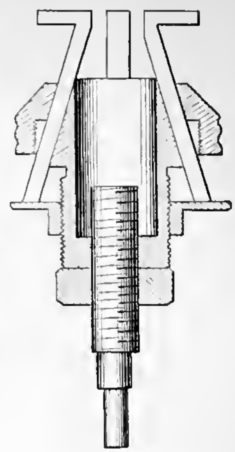


Auger-Gage.

The example (Fig. 445) has a pair of bars, secured by temper-screws to the spiral shank, so as to form a gage of depth.

Another form has a telescopic tube attached to the shank, larger in diameter than the worm, and adjusted as to length by means of two temper-screws whose ends bear against the spiral shank.

Fig. 446



Gage for Hollow Auger.

Fig. 446 is for making tenons of a given length on the ends of spokes, etc., and is adapted for hollow augers. The rear of the stock has a thread traversed by an adjustable screw, which, by contact with the end of the stick, determines the depth of the hole and consequently the length of tenon to be cut. A jam-nut secures the adjustment.

Au'ger-han'dle. The tang of the auger is inserted perpendicularly into its handle, and the end is usually clinched or riveted on to a washer. Means have been contrived for making the auger removable from its handle, so as to make one of the latter answer for varying sizes of augers, and to dislocate the parts for convenience of stowage.

The devices for this purpose consist respectively of a slotted sleeve, a notched key, a nut on the screw-shank, gripping jaws, a spring catch.

Pliny (died A. D. 79) recommends for auger-handles the wood of the wild olive, box, oak, elm, and ash. He says nothing about the augers.

Au'ger-mak'ing Ma-chine'. Augers are made by different processes. They are cast; swaged between dies; twisted as they pass through dies or by the successive motions of the parts of sectional dies; or they are grasped by tongs and twisted by the hands of a skilled workman, and afterwards finished between dies.

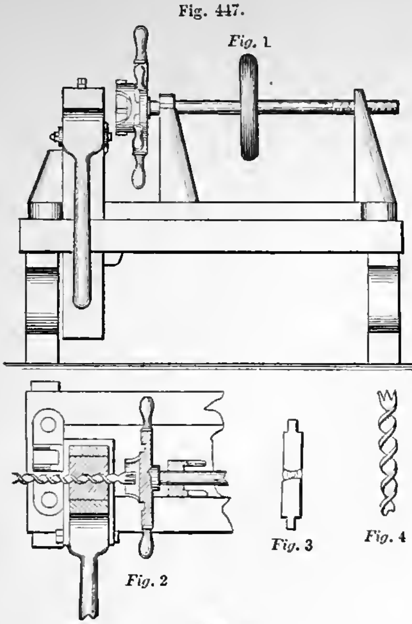
One maker casts the screw-auger in a two-part flask, the pattern of the central shaft and the segmental spirals being so divided as to permit them to be drawn from the sand piecemeal.

Many of the inventions in this line refer to dies of peculiar form, and successions of dies of such form as to cause the blank to gradually assume the shape required. One has a pair of swaging dies, by which the twist is formed either by a succession of blows or by drawing through. The lips are made between dies of the required form, or are bent down by an operation subsequent to the formation of the spiral shank.

Fig. 447 is a machine for turning the lips of augers. The spiral shank is clamped between the jaws with the lips projecting toward the wrench. The latter being advanced, the hub in its center embraces the center point and the lips of the auger. The workman then seizes one of the handles of the wrench-wheel and turns it towards himself, and while the auger is held straight by the engagement of its center point in the axis of the hub, the wrench bends the lips into the required position, the lips being turned simultaneously and their shoulders being left in the same line. Fig. 1 is a side elevation; Fig. 2 a horizontal section; Fig. 3 is a face view of the wrench, and Fig. 4 is a view of the blank before the lips are turned.

In another machine the revolving and longitudinally moving shaft has a transverse slot in its end,

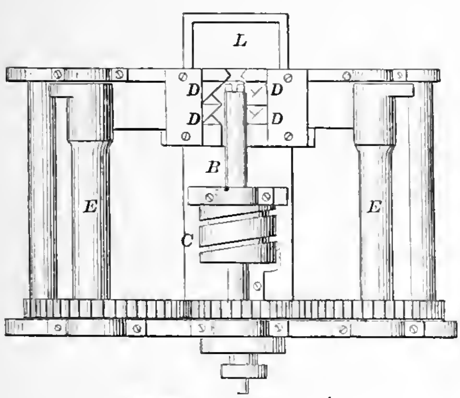
Fig. 447.



Auger-Machine.

in which the flat portion of the blank *A* (Fig. 449) is inserted, the shank being held by a pair of tongs.

Fig. 448.

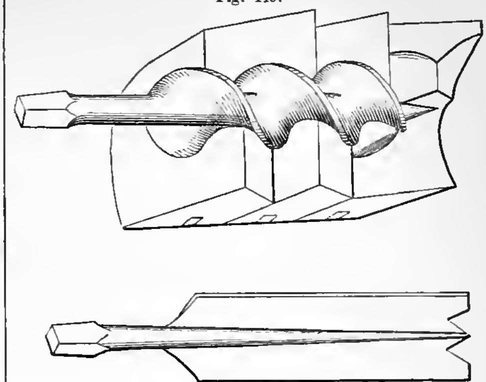


Machine for making Augers.

A series of dies, *D* (Fig. 448), arranged to clasp and hold the auger as fast as it is twisted, completes the process in one operation. The screw *C* on the shaft *B* gives an intermittent longitudinal movement to advance the blank, which is twisted by the continuous rotary movement. *A* (Fig. 449) represents the blank, which is forged or swaged in a drop, and has a longitudinal rib or feather running along its center to insure the requisite stiffness and strength.

The shaft *B* (Fig. 448) is provided with a cylinder *C*, having a screw, or spiral groove, cut upon its surface, with a gaining twist. A pin secured to the frame under the cam works in the grooves, serving as a nut. The shaft, being rotated by the crank or a pulley, is drawn back as it turns by means of the screw-cam. When half a turn is made, the first of the jaws *D D* are forced together by means of the cams on the shafts *E*. The first pair of jaws seize the auger, and, being the exact nega-

Fig. 449.



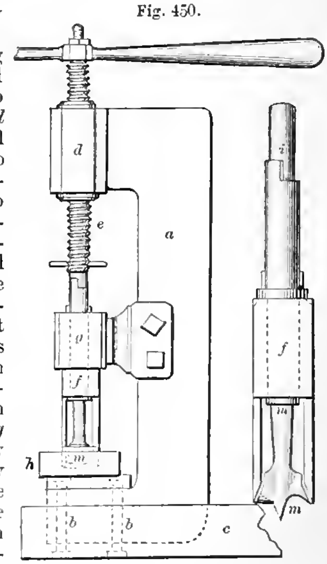
Auger-twisting Dies and Blank.

tive of its twist, hold it firmly and prevent further twisting. The next pair come to their work on the next half-turn, and so on until all the jaws have performed their office, when springs under the jaws force them simultaneously apart as the cams rotate past their centers. It will be seen, by reference to Fig. 449, that the faces of the jaws are dies, exactly corresponding to the twist of the auger.

Au'ger, Square-hole. An auger to cut square holes was described in the Journal of the Franklin Institute, Philadelphia, 1826, as the invention of Mr. A. Branch, of New York. It consisted of a twisted auger operating in a square socket which had a sharp lower edge, and which cut away the margin of the square hole as the auger itself bored a round hole in advance.

HANCOCK'S *Square-hole Borer* (English) was in operation about the same time in London, and operated in a substantially similar manner. *a* is a strong frame, fastened by screws *b* to the bench *c*; *d* is an octagonal socket tapped to receive the vertical screw *e*; to this screw is attached, by a circular tenon and mortise, the square perforating instrument *f*, which slides up and down through a rectangular hole in a brass guide *g* when the screw *e* is turned by the cross-handle at top. The square incision is made by direct pressure downward, at the same time that the center-bit *m* cuts out a round hole, the chips rising up and passing out at

Fig. 450.



Hancock's Square-hole Auger.

the two open sides of the square cutter. *h* is a piece of wood being bored.

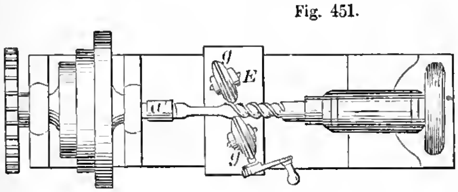
The detached auger is shown on a larger scale; the tenon *i* is inserted in a cavity in the screw *e*, and made fast by a cross-pin which goes through both. This arrangement allows a ready substitution of augers of different sizes. The lower extremity of the revolving portion holds the center-bit *m*, which, owing to the collar *n*, cannot ascend or descend without the square cutter which cuts out the angles beyond the range of the circular borer.

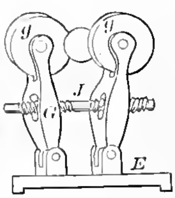
The square-cutting tool is a bar of steel with a round hole drilled out of the solid, and the edges are formed by filing and grinding them to the bevels, shown in the enlarged figure.

MERRITT's *Machine for boring Angular Holes*, May 24, 1864. The holes are bored by rotary cutters; fixed, and reciprocating in a plane at right angles to the axis of the hole. The relatively fixed auger makes a round hole, as usual; certain cutters which partake of the circular motion have also a reciprocation towards and from their axis of rotation, being projected outward and again retracted four times in a rotation, to cut out the angles left by the round auger, thus making a square hole. See BORING-MACHINE.

Au′ger-twist′er. A machine for giving the twist to blanks for screw-augers. There are many forms of machines for this purpose; in one the blank is pressed between rolls upon a slide-rest, which are drawn together by a hand-screw. The blank is twisted simultaneously with the action of the rollers *g g*.

Fig. 451.



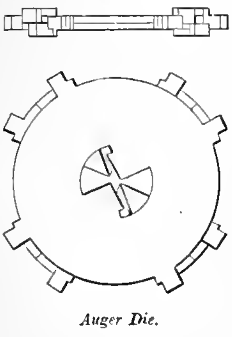


Auger-Twister.

The twist is regulated by the rate of longitudinal motion of the rest *E* upon the ways of the lathe, relatively to the rate of revolution of the front center *a*, which carries the blank. The degree of proximity of the rollers *g g* is determined by the right and left screw *J*, which gives an adjustment of the carriers *G* on the rest *E*. The screw *J* is operated by the hand-crank shown in the plan-view.

In another form the auger-die consists of a series of pairs of circular metallic plates, superimposed on each other, each plate having a peculiarly shaped mortise through the center, and provided also with projecting and overlapping studs upon its periphery. When these plates are arranged so that all the mortises are in line, they admit the flat bar of heated metal, which forms the auger-blank. The upper plate is then revolved, and after a certain extent of motion its stud engages the one below it, which is moved to a corresponding extent, and the action is imparted to each disk in consecutive order, bringing the flat blank into a regular spiral. The opening of the disk-sections releases the auger.

Fig. 452.



Auger Die.

Au-get′; Au-gette′. (*Mining.*) A priming-tube connecting the charge-chamber with the gallery, or place where the slow-match is applied.

Au′ral In′stru-ments. See ACOUSTIC INSTRUMENTS.

Au′ri-cle. An artificial external ear, made of gutta-percha, bleached and colored. Retained by hand or clasp.

Auricles consist of two trumpets shaped like ram's horns, and connected by an adjustable spring passing over the crown of the head. They are flattened on one side in order to fit closer. The mouthpiece, being above the ear, is pointed forward; the neck, passing back and downwards close to the ear, tapering towards the ear-piece, which is made of soft rubber or ivory. They are easily concealed, especially by ladies, who can dress their hair over them.

The interior ear is furnished with the means of dealing with the three characteristics of sound: its typanum, for intensity; its cochlea, for pitch; its semicircular canals, for quality.

Au-ric′u-lar Tube. A speaking-tube; either portable for the use of deaf persons, or between stories, apartments, or parts of an apartment, for the conveyance of messages.

Au′ri-lave. An ear-brush.

Au′ri-scalp. An instrument for operating upon or cleaning the meatus auditorius.

Au′ri-scope. (*Surgical.*) An instrument for ascertaining the condition of the Eustachian passage.

Au′rum ful′mi-nans. Fulminate of gold. A powder of gold and aqua regia. So called from the report it makes when exploded by percussion or attrition.

Au′rum mu-si′vum. Sulphuret of tin, used as a bronze powder.

Aus-cul-ta′tion In′stru-ment. An instrument for the purpose of distinguishing diseases of the viscera by observation of sounds in the part affected. It is particularly applied to the thorax. See STETHOSCOPE; PLEXIMETER, etc.

Au′tho-type. A type or block containing a fac-simile of an autograph. Such are or were used for franking official envelopes, signatures to routine correspondence, and as labels to prevent fraudulent imitations of the contents of the package.

Au-to-chro′no-graph. An instrument for the instantaneous self-recording or printing of time.

Au′to-clave. A French stewpan, with a lid ground on, steam tight. The lid is clamped down on its seat by twisting it round under ears on the side, or by means of a bail and screw, a gasket of linen being used. It is a form of Dr. Papin's digester, and should have a safety-valve. See DIGESTER.

Au-to-dy-nam′ic El′e-va-tor. One in which the weight of a falling column of water is made to elevate a smaller column to a hight above the source; and in which the changes of the valves are automatically produced.

Such are water-rams, the fountain of Hero, etc. See WATER-ELEVATOR.

Au-to-ge′ne-ous Sol′der-ing. The junction by fusion of the joining edges of metals, without the intervention of solder. The edges, being brought together and brightened, are held under a jet of burning gas urged by a blow-pipe, which melts the edges so that they run together.

Au-to-graph'ic Ink. Ink suitable for transferring to stone, writings or drawings executed in it upon prepared paper. Transferring ink.

Dry soap	100
White wax	100
Mutton suet	30
Shellac	50
Mastic	50
Lampblack	30

melted, and worked into an ink.

Au-to-graph'ic Pa'per. Paper prepared to receive a drawing or writing in a suitable ink, and to part with the same to the surface of the lithographic stone or zinc plate, in the process of transferring. The paper is covered with size, which resists the penetration of the ink into the paper. The drawing or writing is executed on the sized surface, so that when the paper is damped it may become detached from the ink, instead of carrying some of the ink away with it, as it would do if the ink were allowed to be partially absorbed by the paper. The size is made of

Starch	120
Gum-arabic	40
Alum	21

This is spread on the paper, which is then dried and pressed.

Or, for transfer of writing to stone, lay on the paper three successive coats of calves'-foot jelly, one layer of white starch, one layer of gamboge. Allow each to dry before applying the next. Smooth by passing through the lithographic press. Write on the gamboge surface. In transferring, damp the paper, place the ink-surface on the stone, and run it through the press. The ink leaves the gamboge surface and adheres to the stone.

A very fair transfer may be obtained from a good quality of writing paper.

Au-to-graph'ic Press. A portable printing-press for taking impressions of autograph signatures from a lithographic stone, or form of type.

Au-to-graph'ic Tel'e-graph. Invented by the Abbé Caselli. An instrument for transmitting autographic communications, accomplished by the aid of two pendulums having a movement absolutely synchronous. One of the pendulums carries a pen or pencil of fine platinum wire, in connection with the line and the line battery, over the surface of the dispatch previously written in insulating ink upon a metallic paper. The other pendulum, at the corresponding station, carries an iron pencil, likewise in connection with the line, over a paper prepared with a solution of the yellow cyanide of potassium. The electric circuits are so disposed, that when the platinum point in its passage over the original writing touches the metallic surface of the paper, there is no emission of current along the line; while, on the other hand, when the point touches the insulating ink, an emission of current takes place, and the iron point passing at the other end of the line over the prepared paper leaves on it a blue mark. The movement of the two pendulums being precisely equal, the reproduction of the dispatch is absolutely exact.

The same apparatus has been made to transmit portraits executed in insulating ink upon metallic paper.

Au-to-mat'ic Fire. The automatic fire or explosive mixture of the Greeks was made from equal parts of sulphur, saltpeter, and sulphide of antimony, finely pulverized and mixed into a paste, with equal parts of the juice of black sycamore and liquid asphaltum, a little quick-lime being added. The rays of the sun would set it on fire. — DRAPER.

Au-to-mat'ic Lamp. A lamp used by dentists in the operation of vulcanizing. When properly adjusted, the flow of gas or alcohol is arrested by a spring cut-off, released by the breaking of a fusible alloy, and extinguishing the flame when the heat reaches a point slightly above that required to finish the process of vulcanizing.

Au-to-mat'ic Mal'let. A tool used by dentists in plugging teeth. There are several forms, but they agree in the delivery of a blow by pressure of the tool on the filling of the tooth cavity. See DENTAL HAMMER.

Au-to-mat'ic Valve. A valve operated by the fluid in progress, in contradistinction to one operated by the positive action of a part of the machinery.

Au-tom'a-ton. A machine whose motive-power is concealed within itself, or, as the term is more generally understood, a machine which imitates the actions of men or animals, and, being moved by clock-work or other similar instrumentality, *appears* to perform certain acts by its own volition. Among the most remarkable of antiquity were the automatons of Hero of Alexandria, who flourished about 217 B. C. They were made to move, as if alive, by machinery under the floor, and to utter sounds by the action of air driven by water through small pipes, or by means of air rarefied by heat. His works are extant in Greek, and have been frequently translated. They contain many curious anticipations of modern devices, as well as many curious tricks and effects no doubt intended as a part of the machinery of the priests to amuse the speculative and astound the ignorant. Archytis's flying dove was made about 400 B. C. Friar Bacon's speaking head, 1264 A. D. An automatic coach, horses and passengers, was made by Camus for Louis XIV. when a child. Vaucanson made an artificial duck which quacked, ate, and drank; its food undergoing a change simulating digestion. Vaucanson also constructed a flute-player, 1738. The writing automaton was a pantograph, deceptively worked by a confederate, 1769. The automaton chess-player was also a deception, 1769. Maelzel made a trumpeter in 1809. An automaton speaking several sentences was exhibited in London about 1810. See Brewster's "Natural Magic."

The speaking machine invented by a Viennese, exhibited in Europe many years since, and lately in this country, is not an automaton, but is played by keys. The thorax is a bellows, and the sounds are made by the passage of air past reeds which simulate the larynx, and modulated by artificial tongue, palate, teeth, and lips.

The drawing automaton constructed by M. Droz, of the Chaux de Fronds, was a figure of a man the size of life, operated by clock-work and springs, and capable of executing six different drawings. It used a metallic style, and drew on vellum. The transitions from one point to another were done by lifting the style, without slurring. It is fully described in Dr. Hutton's Mathematical Dictionary.

M. Malliardet's writing automaton executed four pieces of writing in French and English. It was the figure of a boy resting upon one knee and drawing with a pen upon paper laid on a brass tablet. The writing consisted in each case of several lines, and, after finishing each line, the figure returned to the beginning of the line to dot and cross the letters. The hand has two horizontal and one vertical motion; the down strokes of the pen were made relatively thicker by an increase of pressure.

The annexed engraving is a fac-simile of a drawing executed by the automaton of M. Droz.

Fig. 453.

Cupid.

Au-tom'a-ton Bal'ance. A machine for weighing planchet or coin, automatically sorting the pieces into *full* and *light* weight, respectively. See Coin-weighing Machine.

Au-tom'e-ter. An instrument to measure the quantity of moisture.

Au'to-phon. A barrel-organ, the tunes of which are produced by means of perforated sheets of millboard.

Au'to-phyte Rib'bon. A Swiss ribbon printed by zinc plates which have been produced by the photozinco process from a real lace original.

Au'to-type. A phototypic process. The gelatine is whipped into a froth with warm water and sugar, skimmed, cooled, cut into blocks, and mixed with the pigments. To this creamy fluid the sensitizing agent, bichromate of potash, is added, and the liquid is conveyed to a trough in a room with orange-colored curtains, where a traveling sheet of paper is covered on one side with the compound. The tissue with its coat of sensitive varnish is then dried, and a piece of the required size is exposed to the sun's rays in connection with a collodion negative obtained in the ordinary manner. The required time having elapsed, the tissue is taken out of the case and plunged into cold water with its face downwards on a plate of glass, metal, or another paper, coated with a light solution of gelatine and chrome alum. The surfaces having united, the whole is plunged in a bath of hot water, when the parts of the composition not hardened by the action of the light are dissolved, and the paper slips off, the tougher parts remaining attached to the plate, and successive rinsings remove the cloud of colored gelatine until the picture is free. This is the Swan process of *Carbon Printing* (which see).

The next step is to prepare the "plate" for the printing-press. This consists of a mode of mounting the carbon-print upon a substratum of similar material backed by a glass or metallic plate, so that the picture may be used as a printing surface. A mixture of gelatine, albumen, and bichromate of potash is mixed and filtered. A sheet of plate-glass, about half an inch thick, is then leveled in a drying-box, warmed up to a temperature of 100° Fahrenheit, and coated with the preparation. In about two hours the first coating is dry. The second coating consists of gelatine, albumen, and bichromates, with the addition of a small quantity of an alcoholic solution of resinous gums; to this is added a *soupçon* of nitrate of silver with a few drops of a solution containing an alkaline iodide. After washing out the excess of bichromate from the first coating, the second preparation is applied to the plate, which is again subjected to a high temperature in the drying-box, and becomes thoroughly dry and ready for use in two or three hours. The tough "negative" film is then laid down upon the plate-glass of the pressure-frame, and the plate, now completely coated with a sensitive surface, is laid upon it. The whole is exposed to the sunlight, and the progress of the printing can be easily ascertained by looking through the plate from the back. After exposure, the plates are well washed in cold water, rinsed thoroughly, and allowed to dry; they are then ready for the press. Subsequent operations depend upon two simple truths: first, that the gelatinous film will absorb water; and, secondly, that any greasy mixture of the nature of printer's ink, or any pigment prepared in like fashion, abhors the contact of water, and absolutely refuses to adhere to those portions of the plate which have absorbed that fluid. The success of the operation does not depend upon the relief of the plate, but on the faculty of gelatine for absorbing water, and then, as a matter of course, resisting the imposition of a fatty ink. See Heliotype.

Au'to-ty-pog'ra-phy. Invented by George Wallis, London.

By this method drawings are so executed that they can afterwards be impressed into soft-metal plates. The drawings are executed preferably on gelatine with a peculiar material which is salient and makes a sunken impression in the plate against which it is driven by passing between a pair of rollers.

The resulting plate is printed from as an ordinary copperplate. See also Molding from Perishable Objects; Nature-printing.

Aux-il'ia-ry or Feed'ing En'gine. Is fitted to supply tubular boilers with feed-water when the large engines are not working and the ordinary feed-pumps are therefore inactive.

Aux-il'ia-ry Screw. A screw in a fully masted vessel; used in calms, working to windward, or in emergencies. It is so rigged as to be unshipped when not in use.

A-vant'-fosse. (*Fortification.*) A ditch at the foot of the glacis.

A've-ler. A machine for ridding the grains of barley of their *awns* or *avels*. A Hummeling-machine, which see.

A-ven'tu-rine. A fancy glass of a brownish color with gold-color spots, produced by small fragments of copper and iron in the mass.

A-ven'tu-rine Glass. This ornamental glass is used for weights and ware, the filings of metal giving a spangled appearance; in imitation of a resplendent variety of feldspar, whose color arises from imbedded minute lamellar crystals of oxide of iron.

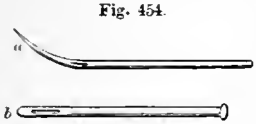
It is prepared by fusing together for 12 hours a mixture of 300 parts pounded glass, 40 parts of copper scales, 80 parts iron scales, and cooling the mixture slowly.

A-ver-un'ca-tor. A long name for a pruning-shears with a long handle, to which the fixed blade is attached; the movable blade is operated by a cord and reopened by a spring. It makes a *draw-cut*. See Pruning-shears.

Awl. A pointed, piercing instrument in common use and of great antiquity. It is evidently older than the needle, which has not yet superseded its use, though it has supplanted it in ordinary sewing. The hides which covered the osier framework of the coracle of the ancient Briton, and the birch bark which covers the canoe frame of the Chippewa Indian, were and are sewn into place by means of an awl, which opens the way for the thong or deer-sinews. The awl is referred to in Exodus xxi. 6, and Deuteronomy xv. 17, where a Hebrew servant who refused to leave his master when his sixth year of bondage was completed, was brought to the door-post and his ear bored through with an awl, after which he became a slave for life. The Egyptian awl of the time of Thothmes III., contemporary with Moses, is shown in a Theban tomb. The pointed instrument was placed in a nearly spherical handle, to fit the palm of the hand. An awl differs from a needle in this, that one is attached to a handle and is retracted, while the other passes through the article and carries the thread which is attached to it.

The sewing-machine needle, so called, is really an awl, except in that small class where the needle and its attached thread are driven through the fabric, making a running stitch (Smith's, Dales's, and others). In many kinds of goods and materials it would seem so much better to have the awl provided with an eye near the end, that it is singular it did not come into general use for sewing machines many years back. The idea was not new, for in the needles used in packing hampers (*a*, Fig. 454) the eye was placed near the point as in a bodkin, *b*, and the twine was pushed through between the meshes of the lid and the basket, so that it could be grasped by the hand without pushing the needle clear through. The upholstery needle and thatching-needle are ancient and eye-pointed.

Fig. 454.

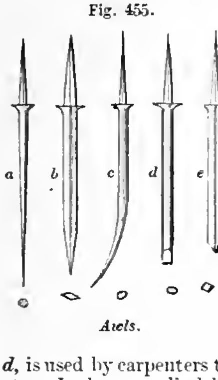


Packing-Needle and Bodkin.

The eye-pointed needle was one of the principal claims in the patent of Elias Howe, Jr., which netted him so large a fortune, and which, originally granted in 1846, was made by an extension to last to 1867.

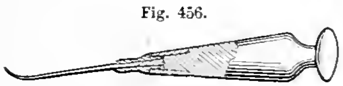
Awls vary in shape with the purposes for which they are intended, The round awl tapered to a point, *a*, is used for a marker or scratch-awl. The awl of a diamond shape, *b*, is used by harness-makers to form an opening for the needles which carry the threads. The round-shanked, bent-ended awl, *c*, is used by shoemakers to make a curved channel, which is followed by the bristle forming the point of the wax-end. The brad-awl, *d*, is used by carpenters to form an opening for brads, etc. It has a cylindrical shank, sharpened to a chisel-edge at the end. The awl *e*, used by wire-workers, is square, and sharp on all four edges; its shape renders it less liable to split the wood.

Fig. 455.



Awls.

Fig. 456.

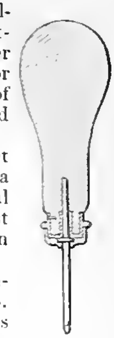


Sewing-Awl.

The sewing-awl (Fig. 456) is used by workers in leather.

The pegging-awl is straight, and is strong enough to drive into wood. The ferrule on the end of the handle is provided with a hollow shank made square. On the outside of the shank is a screw-thread, over which screws a cap having a hole for the insertion of the awl. The flange of the awl is nipped between the cap and head of the ferrule and firmly secured.

Fig. 457.



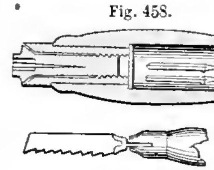
Pegging-Awl.

In one form of pegging-awl the socket gripping the awl is surrounded by a sleeve, which is projected by a spiral spring within the handle, so as to assist in extracting the awl by pressing upon the leather.

A convenient kit of small tools inclosed in a handle is shown in Fig. 458. The serrated shank of either tool is clasped in the gripper as the latter is screwed into the socket. A receptacle in the large end holds the tools.

The awl-handle in Fig 459 is a locking pliers, whose jaws are adapted to hold either of the tools; those not in use are inclosed in the hollow handle when the latter is closed. A boss on the end of the handle forms a hammer. The figure shows an elevation, open; and a section, closed.

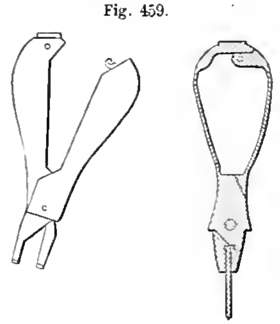
Fig. 458.



Awl and Tools.

In Fig. 460 the eye-pointed awl introduces the thread, which is fed from a spool concealed within the handle.

Fig. 459.



Awl-Handle.

Fig. 460.

Lasting-Awl.

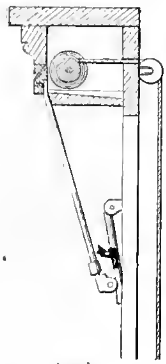
Awn'er. A machine for taking off the *awls* or *awns* of barley. See HUMMELING-MACHINE.

Awn'ing. A shield or shade for protection from the rays of the sun; usually attached to buildings, and especially to protect store-fronts and add to the comfort of pedestrians. The ordinary mode of supporting a roll of canvas, by means of rafters resting against the building and upon posts at the curb, need hardly be described. The canvas is tacked to a roller and is furled by means of a running rope, being protected, when furled, by a pent-roof on the wall of the building.

So far as ingenuity has been exercised upon this subject it has generally been upon modes of lowering and winding, having especial reference to shading sidewalks and show-windows. Some devices, however, have been intended for window-shades, and are modified in shape and mode of operation to suit their location.

Awnings of *linen* were first used by the Romans in the theater, when Q. Catulus dedicated the Temple of Jupiter, B. C. 69. After this, Lentulus Spinther is said to have first introduced *cotton* awnings in the theater at the Apollinarian Games, July 6, B. C. 63; they were red, yellow, and iron-gray. By and by, Cæsar the Dictator covered with awnings the whole Roman Forum, and the Sacred Way, from his own house to the ascent of the Capitoline Hill; this was 46 B. C., and is said to have appeared more wonderful than the gladiatorial exhibition itself. Afterward, without exhibiting games, Marcellus, the son of Octavia, sister of Augustus, when he was ædile and his uncle consul the eleventh time, on the day before the Kalends of August, July 31, 23 B. C., protected the Forum from the rays of the sun, that the people engaged in lawsuits might stand with less injury to their health. Pliny says: "What a change from the manners that prevailed under Cato the Censor, who thought that the Forum should even be strewed with caltrops!"

Fig. 461.

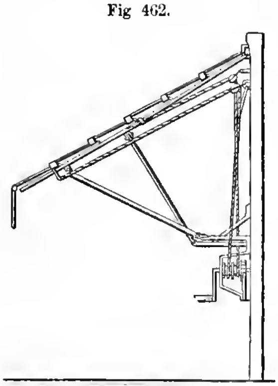


Awning.

The awnings extended, by the aid of ropes, over the amphitheater of the Emperor Nero, were dyed azure like the heavens, and bespangled with stars. The *atrium*, or hall of audience, of the Roman houses, had an opening in the middle, which was covered in summer with a red awning.

In Fig. 461 the awning is rolled upon a shaft having permanent bearings in the box which assumes an architectural form in the entablature of the shop-front. The hem of the awning is fastened to a bar, which, when closed, forms the architrave, but which swings open when the awning is unfurled from the roller in the box, and is supported by jointed extension-bars from the pilasters of the store-front. As the awning unwinds, the hoisting-rope coils on the roller, and becomes the means of refurling.

Fig 462.



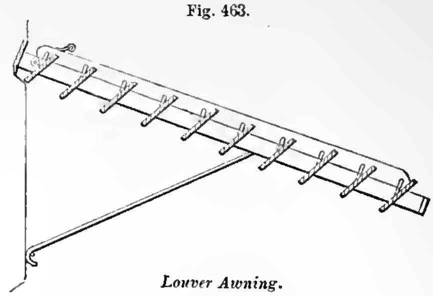
Metallic Awning.

In Fig. 462 the metallic plates which form the awning are arranged to lap one over another, each plate being fitted between guides, which are attached to the lower end of the plate immediately above it. The plates are connected to toggles, which are operated by arms and a windlass, to raise and fold the plates, or to distend them into effective position.

In the Louver awning each slat of the awning is pivoted in the rafter, and is connected by crank-arms to a bar which is operated by cords, so as to act, like a Venetian shutter, upon all the slats simultaneously and exclude the direct rays of the sun, while permitting a diffused or reflected light to enter the store.

In another form the light wooden slats of the awning fold over each other like the leaves of a fan. The slats are arranged on a suitable frame, and

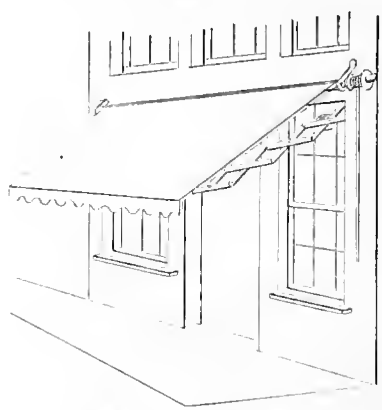
Fig. 463.



Louver Awning.

there are two pulling cords, one of which spreads the awning and the other folds it up.

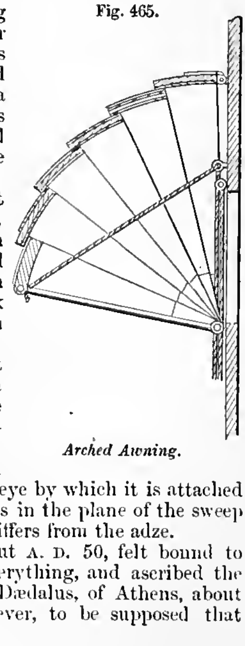
Fig. 464.



Lazy-Tongs-Extension Awning.

In Fig. 464 the lower edge of the awning is attached to the boards, which are secured to the side extensors. The extensors are made in toggle-sections, operating as lazy tongs. The upper edge of the awning is coiled on a roller operated by a cord; it is held by a pawl, to keep the canvas stretched. The spiral spring acts to keep the arm extended.

Fig. 465.



Arched Awning.

Fig. 465 shows front and tapered side-slats, which slide one beneath the other, being connected together by plates with headed studs, which work in slotted plates affixed on the adjacent slats.

The end-slats collect like the folding parts of a fan; the roof-slats take position in vertical parallel series when closed.

Axe. A chopping and felling tool. It has an eye by which it is attached to the helve. The edge is in the plane of the sweep of the tool; it therein differs from the adze.

Pliny, who wrote about A. D. 50, felt bound to state an inventor for everything, and ascribed the invention of the axe to Dædalus, of Athens, about 1240 B. C. It is, however, to be supposed that when Cecrops, three hundred years before, forsaking Egypt and leaving civilization behind him, landed in Greece, he had axes wherewith to clear a spot for the village he founded.

About the year 1093 B. C. we read that the Hebrews went to Philistia "to sharpen every man his axe" (1 Samuel xiii. 20); and about 893 B. C. "the axe-head fell into the water" while the man was chopping (2 Kings vi. 5). Previous to these two latter dates, and two hundred years before the time of Dædalus, we find that the Mosaic law, 1451 B. C., had anticipated the following supposed case: —

"As when a man goeth into the wood with his neighbor to hew wood, and his hand fetcheth a stroke with the axe to cut down the tree, and the head [Hebrew, *iron*] slippeth from the helve, and lighteth upon his neighbor that he die, he shall flee unto one of those cities [of refuge] and live."

In Deuteronomy xx. 19, it is forbidden to "force an axe" against the fruit-trees of a besieged city, 1451 B. C. Later, so valuable was skill in the use of this tool, we learn that "a man was famous according as he had lifted up axes upon the thick trees" (Psalms lxxiv. 5).

The axe has a cutting edge of steel attached to a wrought-iron head, which has an eye parallel to the chord of the curved cutting edge. It is found among all nations who have the material and skill for its manufacture, the substantial form having descended from the stone age, when a withe or elastic handle was bent around a circular depression on the head, and the edge was sharpened to the extent the constitution of its material would bear, or according to the means at hand for dressing it; as in the case of chipping an edge on a flint hatchet.

Fig. 466.

Primitive Axe.

The accompanying cut represents a stone axe of highly polished, dark greenstone, found within a primitive canoe, at a depth of 25 feet below the surface of the ground, in the Valley of the Clyde, Scotland. The canoe was hewn out of a single oak, and was exhumed from beneath the site once occupied by an ancient church. This axe is exactly like a number which have been recovered from the mounds and fields of the West. It is the same weapon termed a *celt* by archæologists.

The axes, fasces, trumpets, sacrifices, divination, and music of the Romans were introduced from the Etrurians. Auger and oracle still exist in the land of their adoption.

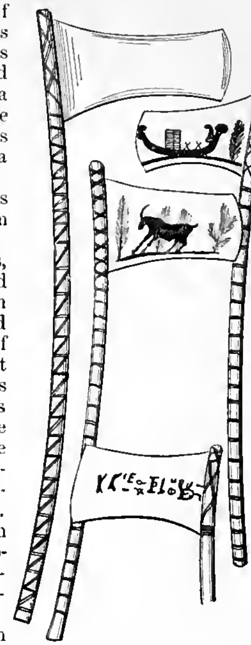
The mention of the axe (ἀξίνη) occurs frequently in Greek authors. A crooked one for shipbuilders, and a double-bladed one for a weapon, are also mentioned. The English word *stale* for an axe-helve is derived from the Greek.

The Roman *bipennis* was a double-bladed axe with the eye in the center, like some of our modern ones. See DOUBLE-BITTED AXE.

The Egyptian axe was of iron, steel, or bronze; the color seems to indicate the former metal in some cases, but it was generally of bronze. The handle was split to receive the blade, which was secured by bronze pins and leather thongs. It was used as a weapon in felling timber, shivering gates, etc.

Figure 468 shows three Egyptian axes. The larger one belonged to Salt's collection, and is now in the British Museum. The blade is of bronze, 13½ inches long and 2½ inches broad. It is secured by silver pins in a tube of the same metal. The tube was adapted to contain a wooden handle.

Fig. 467.



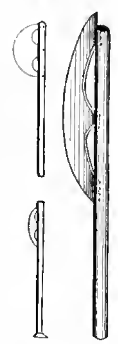
Egyptian Axes (Thebes).

The other figures are of axes from Thebes.

The Peruvian axes, chisels, knives, and awls were made of an alloy of copper and tin. The bits of their axes were about the same shape as ours, but the heads were inserted in the handle instead of the handle in the axe-head. Iron was unknown among them. Tin, added in certain proportions to the copper, gives it the hardness of steel. See ALLOYS: ANNEALING.

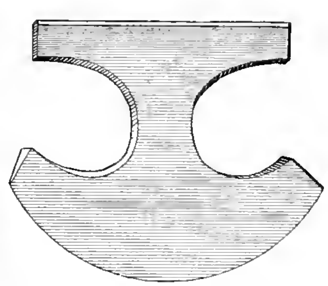
Copper axes with single and double bits have been found in a *tumulus* near Chillicothe, Ohio. A small hole through the middle of the two-edged axe indicates that it was secured to the helve by lashing.

Fig. 468.



Egyptian Axes.

Fig. 469.



Peruvian Knife or Axe.

The single-bitted axe is solid and well hammered, and weighs two pounds five ounces. It is seven inches long and five broad at the cutting edge, having an average thickness of two fifths of an inch. Its edge is slightly curved, after the manner of modern axes, and it is beveled from both sides. Copper chisels, gravers, etc., are also found in the American mounds.

Lubbock states that the bronze axes, of the ages when that metal predominated, were all destitute of eyes for the handles.

The following are various kinds of axes: —

Barking-axe.	Chip-axe.
Battle-axe.	Cleaver.
Bill-hook.	Double-bitted axe.
Brick-axe.	Felling-axe.
Broadaxe.	Grubbing-axe.
Cavil.	Halberd.

Hand-axe.
Hatchet.
Jedding-axe.
Machete.
Pickaxe.
Pole-axe.
Side-axe.
Slate-axe.
Stone-axe.
Tomahawk.
Zax.

See these in their alphabetical places in the body of the work.

The *felling*-axe of the artillery is of the following dimensions: —

Length,	7.25 inches.	
Width of top,	3.50 "	
" " edge,	4.75 "	
Thickness at top,	0.75 "	
" " eye,	1.25 "	
Size of the eye,	2.25 "	× 0.75 inches.
Handle (hickory),	27. "	long.
Weight,	6 pounds.	

In the most recent process for making axes, hammered bar-iron is heated to a red heat, cut off the requisite length, and the eye, which is to receive the handle, punched through it. It is then reheated and pressed between concave dies until it assumes the proper shape. It is now heated and grooved upon the edge to receive the piece of steel which forms the sharp edge. To make the steel adhere to the iron, borax is used. This acts as a soap to clean the metal in order that the parts may adhere. At a white heat it is welded and drawn out to a proper edge by trip-hammers. The next process is hammering-off the tool by hand, restoring the shape lost in drawing out; it is then ground, to form a finer edge. Afterwards it is ground upon finer stones, and made ready for the temperer. The axe is now hung upon a revolving wheel in a furnace over a small coal-fire, at a peculiar red heat. It is cooled successively in salt and fresh water, and then tempered in another furnace, where the heat is regulated by a thermometer. It is then polished to a high finish, which will show every flaw and enable it to resist rust. It is then stamped, and the head blackened with a mixture of turpentine and asphaltum.

Axes have been made partly of iron and partly of steel, or of different qualities of steel, by pouring into a mold first one of these metals in a molten state, and then the other metal, thus superseding welding. The steel portion is cast thick in the first place, and then drawn under the hammer.

Axes are *cast*, *rolled*, swaged between dies, or forged with the hammer.

The portions of an axe are known as the *bit*, *poll*, *eye*, and *head*.

Inserting a steel *bit* in the cleft *head* is known as *steeling*, and thus are axes refitted when the old head is worthy of such repair.

Fig. 470 shows an axe with a head of iron, cast into and around a steel bit, previously inserted in the mold. The axe is then finished and dressed.

The axe (Fig. 471) is made by pouring steel from a crucible into a mold, a core maintaining the shape of the eye.

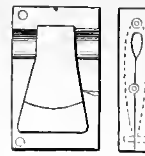
In Fig. 472 the steel is bent and lapped around the edge of the iron portion to which it is welded, instead of being inserted in the split edge of the axe-head, — an inversion of the position.

The continuous blank, from which axe-heads may

Fig. 470.

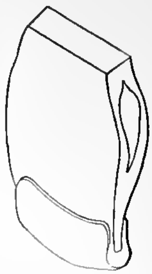
Lippincott.

Fig. 471.



White.

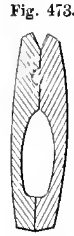
Fig. 472.



Mann.

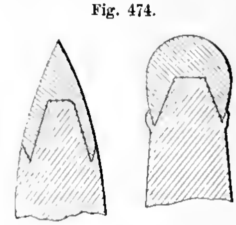
be cut by a transverse section, is made in two pieces, which are hollowed to form the eye, and have a matching bead and groove to fit the portions together. The transverse section (Fig. 473) shows the shape of an axe without the steel, which is subsequently inserted into the notch and secured by welding.

Fig. 473.



Axe-Blank.

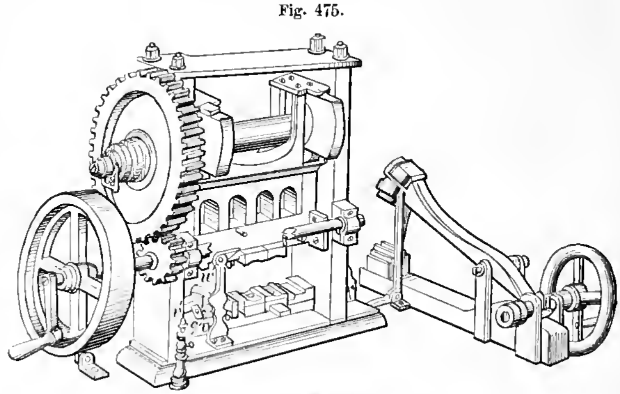
Fig. 474.



Lippincott.

The bifurcated edges of the steel bit in the example (Fig. 474) are inserted into a scarf on each side of the stock, which is thus made to lap over the bit, and is welded down thereon, as in the left-hand figure.

Fig. 475.

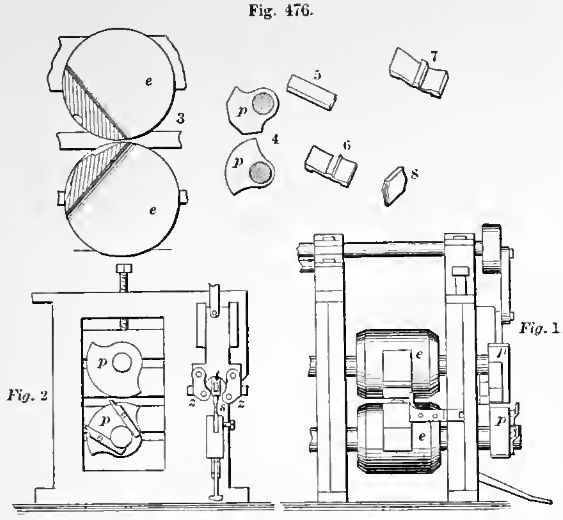


Axe-Machine.

In the axe-making machine (Fig. 475) a series of dies are arranged in the bed beneath and the reciprocating block above. They cut off the blank for the axe-head, and shape and weld it while being held between the dies by means of a mandrel in the hands of the attendant. At the side of the machine is a punch for trimming the eye and a trip-hammer with suitable dies for trimming the head. The axe under treatment is moved from one operative part of the machine to another, and swaged to form by successive blows.

Fig. 476 represents a machine in which the axe is made by successive operations between dies.

Fig. 476.

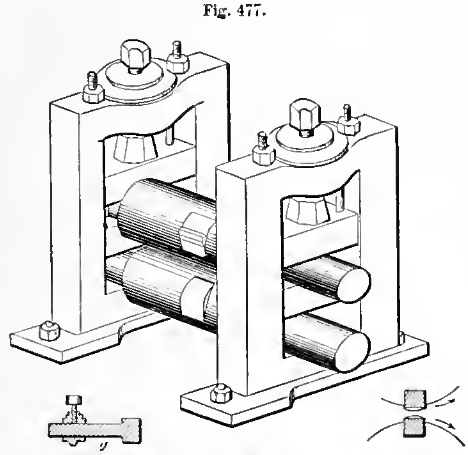


Hutchins's Machine for making Axes.

In this illustration, Fig. 1 is a front elevation; Fig. 2 is a side view of the dies *p p*, and Figs. 3 and 4 are sections of the dies. Fig. 5 is the iron blank. Figs. 6, 7, and 8 are the shapes it successively assumes as it comes from between the roller-dies *e e* and *p p*, and the bending apparatus *z s t*. The dies, by successive operations, give it the proper shape on both sides; it is then placed on the upper face of the *former*, which corresponds to the inner surface of the eye. The head is gripped by the jaw, which is depressed by a treadle; the carriage is depressed by the crank-rod, and the rollers *z z* bring the iron to shape.

In the machine (Fig. 477) the axe-heads are manu-

Fig. 477.

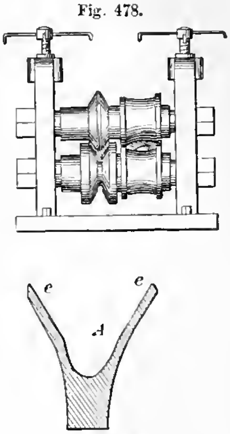


Axe-Blank Machine.

factured by compressing only one half thereof, at each operation, between dies or swages of the required shape projecting from the face of the rolls in which they are set, so that the axe-head can be inserted and withdrawn without coming in contact with the rolls; the adjustable guide *g* is either attached to the dies or separate therefrom, for the purpose of applying the pressure necessary to form the axe-head, in such a manner as to leave any excess or deficiency of iron in the poll of the axe-head, thus securing exact uniformity in the two sides thereof, and enabling axes of various sizes to be made from the same dies by simply adjusting the distance of the rolls and the gage.

In another machine the end of a heated bar is inserted into the machine; the blank cut off; the eye punched by oval punches, while the blank is held and compressed by the movable sections of the die-box, one of whose sides is sharp-edged to open the blank for the insertion of the steel bit.

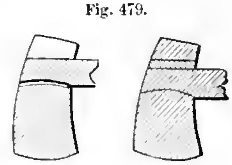
Fig. 478.



Axe-Blank Machine.

Fig. 478 splits and opens a long bar, so that it may be cut up into axe-blanks ready to receive the steel bit. The upper part of the figure shows two runs of rolls, one for rounding and the other for splitting. The lower figure shows the split blank *A*, with two prongs *e e*, to be closed by the blacksmith upon the steel bit which is inserted between them while the parts are at a welding heat.

Fig. 479.



Axe-Helve Fastening.

The axe is usually fastened to its helve by wedging the latter tightly in the eye, splitting the end of the helve for that purpose.

The eye is peculiarly shaped in Fig. 479, one edge being rounded, and the helve of corresponding shape is driven upon it by a wedge at the back.

In Fig. 480 the helve has a metallic strap secured on the end, and this fits between wedges in the eye. A bolt passes through a cap-piece, and extends through the strap and into the helves. A wrench tightens the bolt.

Fig. 481 shows a metallic cap for the hand-hold

Fig. 480.

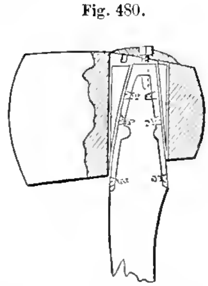
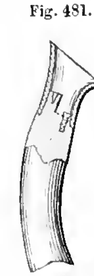


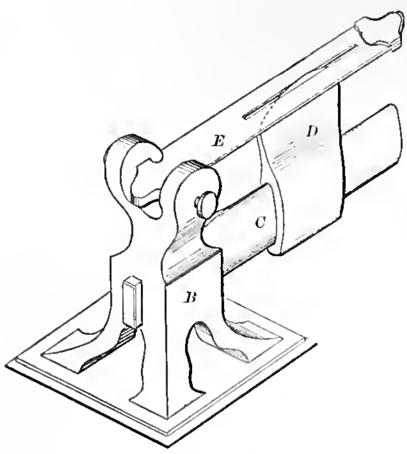
Fig. 481.



of axes. It is secured by a dowel-pin, which penetrates the helve, and a tenon on the latter, which enters a socket in the cap and is wedged therein.

Fig. 482 shows an axe-testing machine. The axe to be tested is slipped upon the bar *C*, towards the

Fig. 482.



Axe-Tester.

standard *B*, until it fits tightly. The gage-plate *E* is then allowed to descend upon the edge of the axe *D*, when, by placing the eye over the slot, the slightest variation from truth may be detected.

Ax'is. A mathematical term. See Axle.

Ax'le. 1. (*Machinery.*) A shaft or rod on which a pulley, drum, or wheel is placed.

Axles in machinery are known as *Live* axles when communicating power; as *Dead* or *Blind* axles when running, but ineffective, temporarily or otherwise.

Hollow axles are tubular, as their name indicates. They become *sleeve*-axles when the tube is occupied by a rod or tube forming a *live* or *dead* axle, or a fixed axis, as the case may be.

2. (*Vehicles.*) The transverse bar beneath a vehicle, upon whose ends the wheels are placed.

In the *carriage*-axle the wheels rotate on the axle-spindle, the axle-tree being relatively fixed.

In the *car*-axle the wheels are fast to the axle, which rotates therewith. The axle has bearings in boxes. See Car-axle.

Carriage and wagon axles are made tubular for strength and lightness; tubular axles are made from welded iron pipes, such as are used for water and gas. The ends are drawn to a taper for the spindles, a butting-ring is then welded on, and the end fitted with a plug on which a thread is cut for the nut. Hollow axles are also made by taking two swaged hollow portions and welding them together. See patents of Lewis, 1871, 1872.

A *divided* axle is one which is bisected at its mid-length; the parts being coupled or otherwise, as the case may be.

The claims to antiquity of this highly useful portion of the carriage do not afford much room for enlargement. The cart and the chariot, whatever may be their order of precedence as regards time, afford the earliest specimens. The details of early forms are comprised in the axle-tree, two spindles, and their linch-pins. Skeins, nuts, straps, clips, boxes, bushing, lubricators, and other devices, seem to have been reserved for the moderns. Axles are made of wood or metal; in the former case the spindles for the wheels are strengthened and preserved by metal (see Skeins), and the axle-tree itself receives straps and bands, secured by clips and bolts, for the same purpose. Pliny, A. D. 79, recommends ash, oak, and elm for the manufacture of axle-trees. See Carriage, Chariot, Wagon.

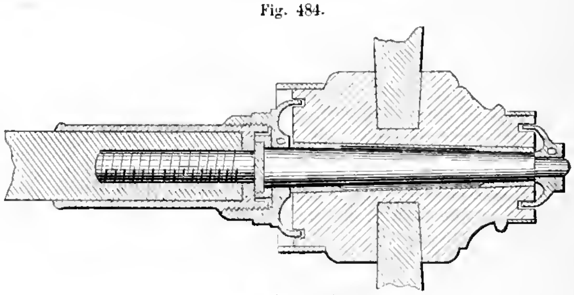
Fig. 483.

Compound Axle.

The arms of the compound truss-axle (Fig. 483) are each made in two parts with an intervening oil-space. One of the parts is placed edgewise, vertically, and the other flatwise, horizontally; the two being united by collars, which form butting-rings, and by screw-nuts, which latter also secure the hubs into the axles.

In Fig. 484 each end of the wooden axle-tree has a cast-metal sleeve, on the outer end of which is a polygonally shaped recess, for a finished metallic spindle, whose shank screws into the end of the axle-tree. A collar on the spindle abuts upon the end of the sleeve and holds it in place. A cap screws on the sleeve, and its flange projects into a face-groove on the inner end of the hub. A similar provision on the outer nut also tends to exclude grit from the bearing surfaces.

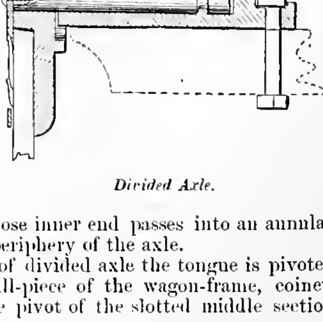
Fig. 484.



Carriage-Axle.

While most wheels revolve on the spindles of their axles, others are fast to and rotate with their axles; in the latter case bearings are provided for the axle (as in Fig. 485), in which the parts of the divided axle rotate in bearings attached to the axle-tree. Each portion is received in a long socket-piece, bolted to the axle, and is retained by a set screw, whose inner end passes into an annular groove in the periphery of the axle.

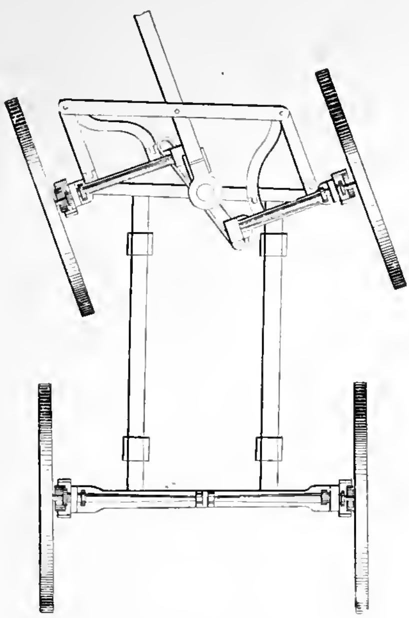
Fig. 485.



Divided Axle.

In one form of divided axle the tongue is pivoted to the front sill-piece of the wagon-frame, coincidently with the pivot of the slotted middle section

Fig. 486.

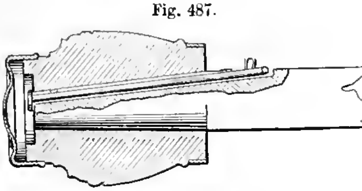


Drew's Carriage-Axle.

of the axle-tree, and the tongue is not affected by the contact of the front wheels with obstructions in the road. The middle section of the axle-tree forms a link in which slip the inner ends of the two outer sections, in which the axles of the wheels have their bearings. Each wheel is secured to its portion of the axle, and each section of the axle-tree is secured by hounds to its respective end of an equalizing bar, which oscillates on the tongue as the wheels swerve out of their course or change their parallelism with the hind wheels. The tongue-hounds are hinged to their sections of the axle-tree, so as to allow the required vertical motion to the tongue, which has also a hingeing joint.

Fig. 487 shows a means of securing the wheel to the axle. It is intended for children's carriages, and

Fig. 487.



Denison's Carriage-Axle.

the fastening is not exposed at the outer end of the hub. A rod is fitted in the spindle of the axle, and provided at its outer end with a button eccentrically attached. The button in certain positions bears upon the outer end of the hub, and the inner end of the rod is secured by a staple and key.

The bent or crank axle is much used in city drays, its purpose being to lower the bed without reducing the size of the wheels. Bringing the floor of the vehicle nearer to the ground obviates lifting the load to any great extent. The bent axle, to enable the bed of the cart or wagon to come near to the ground, while retaining a large wheel, is a common device in England in city and rural vehicles. One form of driving wheel-axles for locomotives is also bent. Baddeley, a contributor to the early volumes of the Mechanic's Magazine, London, advocated their use, and may have been the inventor.

Paterson (England) proposed that carriages should have axles of unequal length, so as to avoid "tracking," and thus prevent the formation of ruts.

A *turning*-axle is the fore-axle of a carriage, which turns on the fifth wheel.

A *leading*-axle is an axle of a locomotive, in front of the driving axle or axles. The term is applied especially to the English engines, which are not supported in front by a four-wheeled truck, as with us.

A *trailing*-axle is the last axle of the locomotive. In English engines it is under the foot-plate.

A *crank*-axle is a driving-axle connected to the piston-rods of a locomotive whose cylinders are *inside*, technically speaking.

A *driving-wheel* axle, or *driving*-axle, is the one on which the driving-wheels are keyed. The power is either applied to cranks on the axle, or to wrists on the driving-wheels themselves.

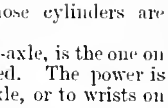
Ax'le-ad-just'er. A machine for *truing* an axle by straightening out the bends; or one for *setting* the spindle in proper line relatively to the axle-tree. See AXLE-SETTING MACHINE.

Ax'le-arm. The spindle on the end of an axle, on which the box of the wheel slips.

Ax'le-bar. An axle-tree with an arm at each end for a wheel.

Ax'le-box. Carriage axle-boxes are bushings for hubs. Their duty is to take the wear incident to revolving on the spindle of the axle. Some of them are so arranged as to unite the wheel to the axle without the intervention of linch-pins or axle-nuts. Others have rollers to diminish the frictional bearing of the spindle in the box. Others have devices for taking up lost motion. Other devices refer to modes of casting, securing in the hubs, renewing the bearing surfaces, providing thimbles and sleeves of soft metal, which prevent the contact throughout of the spindle and its bearing.

Fig. 488.

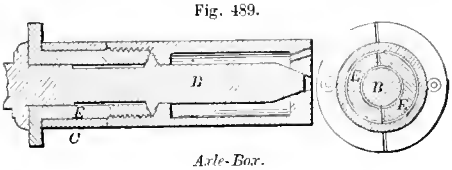


Axle-Box.

In Fig. 488 the spindle has a permanent conical collar, and the box is formed in two portions, which screw together; a groove at the point of junction forming a seat for the collar on the spindle, and holding the latter in the hub of the wheel. The collar is intended to be the only bearing portion, the hole through the box surrounding the other parts of the spindle being made large enough to enable it to revolve without touching.

Somewhat similar is Fig. 489, in which the conical collar on the spindle *B* is used for the same purpose. The inner portion of the box, however, is formed of

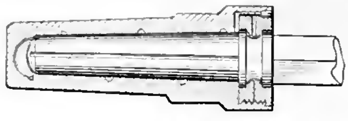
Fig. 489.



Axle-Box.

two semi-cylindrical pieces *E E*, which are held in place, on their portion of the spindle, by a cylindrical band *C*, which slips over them when the parts are in position. The segments have threads cut upon them, upon which the outer portion of the hub is screwed. The tapered end of the spindle *B* abuts

Fig. 490.

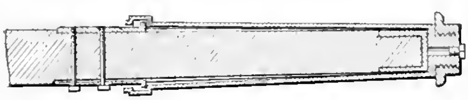


Axle-Spindle

against a conical seat in the outer end of the box. A hole at this end admits oil, and is then plugged.

In Fig. 490 the spindle of the axle has a grooved collar, which occupies the position of the usual butting-ring. The open end of the boxing has an internal thread screwing upon the divided nut, which clasps the collar on the spindle. The box and nut are keyed together by a screw, so as to run together; the nut clasping the permanent collar, so as to keep the wheel on the spindle.

Fig. 491.

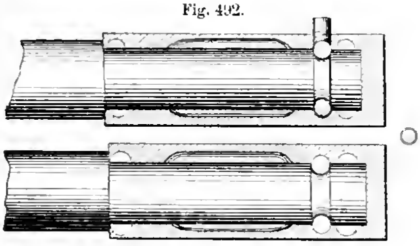


Axle-Box.

The axle-box shown in Fig. 491 is cast solid throughout, and is closed in front by a cap. Linch-pins are attached to the axle, and have projections which enter an interior annular groove of the box, so as to keep the latter on the axle. The oil-hole at the end of the box is closed by a screw-plug after oil is applied.

The axle (Fig. 492) has corresponding annular grooves in the adjacent faces of the axle-spindle and the box. A hole in the hub permits a ball

Fig. 492.

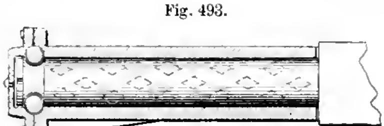


Axle-Box

to be dropped into this groove, and the hole is then plugged. The ball opposes the withdrawal of the box from the spindle. One view is a vertical, and the other a horizontal, longitudinal section.

Fig. 493 has chilled cast-iron balls, which are the means of uniting the box to the spindle; the

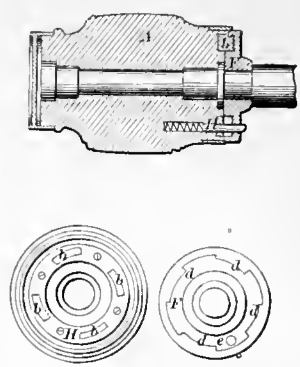
Fig. 493.



Axle-Box.

balls protruding into grooves in the respective parts. The flange on the end of the spindle has a notch to facilitate the introduction of the balls into the groove of the spindle. The outer groove is formed at the junction of the cap and the box, which are secured together by bolts.

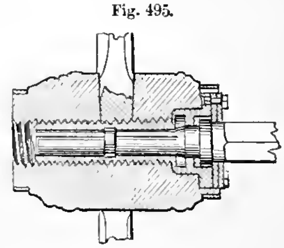
Fig. 494.



Axle-Collar, etc.

Fig. 494 shows another form in which a collar is turned on the inner end of the spindle, and inside the collar is a groove occupied by an annular cap-piece *F*. The cap *F* is to be attached to the inner end of the hub *A*, to hold it on the spindle of the axle. The lips *d*, on the inner face of the cap, enter between the projections *b* on the face of the hub. The cap is then partially rotated, locking the two portions together; the engagement being maintained by a spring pin *H* in the hub, which enters a perforation in the cap *F*. To detach the wheel, the spring pin is retracted and the cap loosened, permitting the wheel to be removed from the spindle.

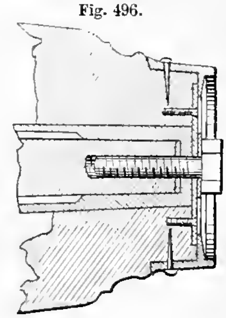
Fig. 495.



Axle-Box.

The box in Fig. 495 has an exterior thread by which it is screwed firmly into the hub. The ends of the spokes rest upon the thread. The box is widened at its inner end, so as to enclose the butting ring upon the axle, and the flange of the box is bolted to an annular plate on the inside of the butting-ring, so as to hold the box to the axle, thereby securing the wheel in place without any attaching devices on the outer end, such as linch-pin or axle-nut.

Fig. 496.



White's Axle-Box.

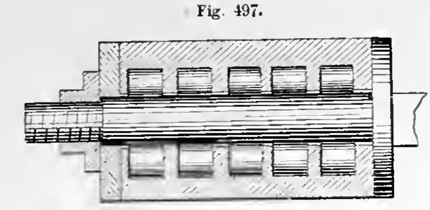
An axial bolt in Fig. 496 screws into the end of the spindle, and its head rests against an annular washer, which is of sufficient diameter to abut against the end of the box and the hub also. The bearing of the attachment is thus upon the outer end of the spindle, the usual butting-ring on the axle is superseded, and the back of the hub removed from any contact with sustaining devices when the wheel vibrates longitudinally on its spindle.

In the axle (Fig. 497), friction-rollers revolve in the annular chambers of the box, and lessen the friction of the spindle; the latter has a rolling contact, instead of a frictional one.

The planetary system of rollers is a very common device, and a great favorite among inventors. It is applied to bearings of all kinds.

The box (Fig. 498) is in two portions, which form conical or beveled bearings of unequal inclinations at each end of the hub; their inclinations being in

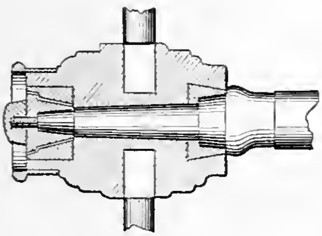
Fig. 497.



Antifriction-Roller Box.

reversed or opposing directions, and the outer having the greater inclination of the two. The attachment is by a nut on the end of the spindle.

Fig. 498.

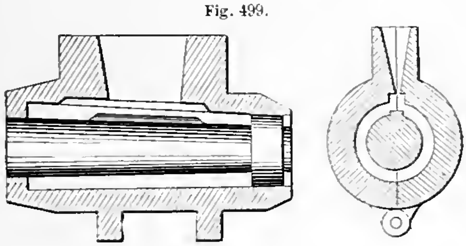


Axle-Box.

Fig. 499 shows a mode of casting axle-boxes in a two-part, hinged, metallic flask, the portion of the gate below the sprue forming the fin of the box. The box is cast upon a chill with a sand core for the oil-chamber.

Upon the butt-end of the box (Fig. 500) is an annular flange with a concave recess formed on its

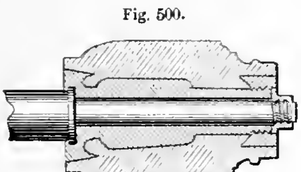
Fig. 499.



Mode of casting Axle-Boxes.

inner surface: the sharp edge of the flange sinks into the wooden hub, and a metallic nut with a corresponding sharp flange is similarly sunk into the other end of the hub. The object is a firm attachment of the box in the hub.

Fig. 500.



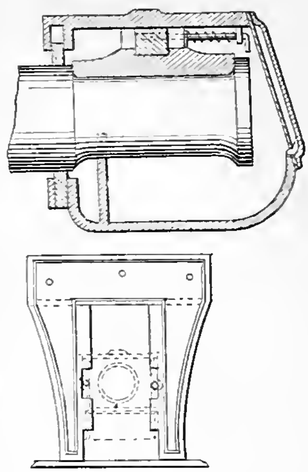
Axle-Box.

A bearing surface, completely enveloping the spindle, is either a bushing for the box, or is allied to a thimble-skein. This skein may be a cast-iron thimble, a wrapping of wire, a bearing of Babbitt-metal, or an infolding plate of sheet-metal. See AXLE-SKEIN.

Axle-boxes of railway-cars are differently constructed, as may be seen by the example annexed. They consist mainly of a box, bearing, packing, oil-chamber, and removable cover.

Arrangements are made to facilitate the removal of the bearing from the journal of the axle, for the inspection of the journal, or the renewal of the bearing, while the oil-box remains in its place; also to so combine the oil-box with the axle and jaw, that the oil-box may be easily removed therefrom, for the purpose of renewing the packing in the rear end, etc. See CAR AXLE-BOX.

Fig. 501.



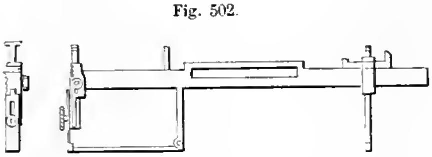
Car Axle-Box.

Ax'le, Car. The bar connecting the opposite wheels of a pair, adapted to support a railway-carriage, or railroad-truck. The wheels are fast to the axle, and the latter runs in bearings in *axle-boxes.* In this respect the car-axle differs essentially from the carriage-axle, which is relatively fixed, the wheels running upon *it.* See CAR-AXLE.

Ax'le-clip. (*Vehicles.*) A clevis or bow which unites some other part to the axle; as the *clip* of the thill coupling. The axle-cap or strip, and the ends of the perch-braces, are fastened by clips to the axles.

Ax'le-clip Tie. The cross-bar which unites and fastens the ends of the bow-clip by which a carriage-axle is clasped.

Fig. 502.



Stratton's Axle-Gage.

Ax'le-gage. A tool by which the spindle is so adjusted in relation to the axle-tree, as to give the required *swing* and *gather.*

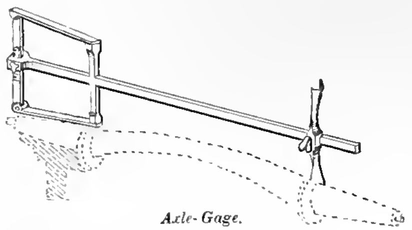
The *swing* is adjusted to give the downward inclination, and the axle is bent to conform to this guide. The *gather* is given by the adjustable standard.

The *swing* is the outward inclination of the top of the wheel, and is to meet the requirements of the conical axle, so that the bottom edge of the spindle shall ride about horizontal. Were the spindle destitute of *swing,* the wheel would ride outward, bearing heavily against the linch pin or nut.

The *gather* is the forward inclination of the spindle relatively to the general line of direction of the axle-tree. It is to bring the forward edge of the taper spindle into a direction nearly transversely across the vehicle, so as to prevent the riding out of the wheel against the hub, which would result from placing a wheel on a conical spindle without *gather.*

Fig. 503 shows a somewhat different form of the gage, in which the concave end of the sliding gage is placed on one spindle, and the other spindle set by the adjustable bars.

Fig. 503.



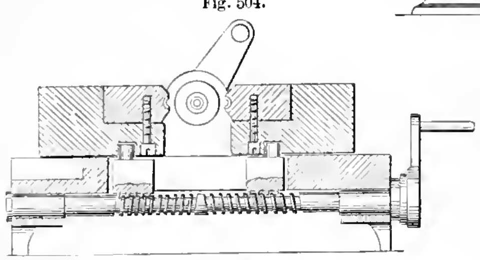
Axle-Gage.

Ax′le-guard. One of the pedestals in which the boxes of an axle play vertically as the springs yield and recoil. Also called *horn-plates, jaws, housings, pedestals.*

Ax′le-hook. (*Road Wagons.*) A hook in front of the axle for the attachment of the stay-chain which connects the axle and the double-tree.

Ax′le-lathe. A lathe adapted to turn axles, shafting, and other relatively long articles which are liable to be swayed or bent by their flexibility or by the pressure of the cutter. Bearings are provided at points between the lathe centers, and sometimes the cutters are duplicated so as to act upon opposite sides simultaneously, as in Fig. 504.

Fig. 504.



Axle-Lathe.

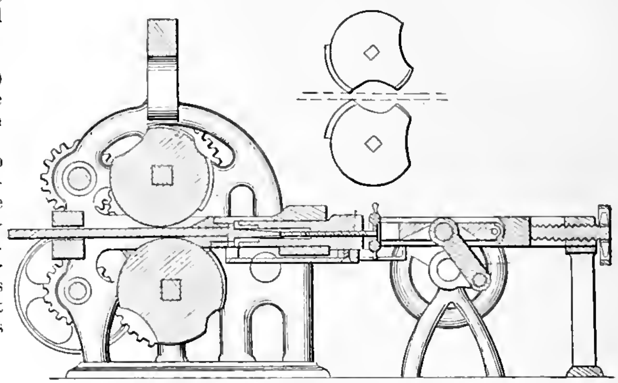
The axle or shafting is turned to form by suitably shaped cutters secured to two jaws, which approach each other by the rotation of a right and left hand screw in a fixed rest.

Whitworth's famous lathe is of this character. See DUPLEX LATHE; CAR-AXLE LATHE.

Ax′le Lu′-bri-ca-tor. A device for containing a supply of oil and supplying it to the spindle inside the axle-box.

There are many forms of this, some having reservoirs of oil in the spindle, others in the box, others outside. In some the lubricant is led to the wearing surface by gravity, in others by cotton wick, in others by a moving cup. See CARRIAGE-WHEEL LUBRICATOR.

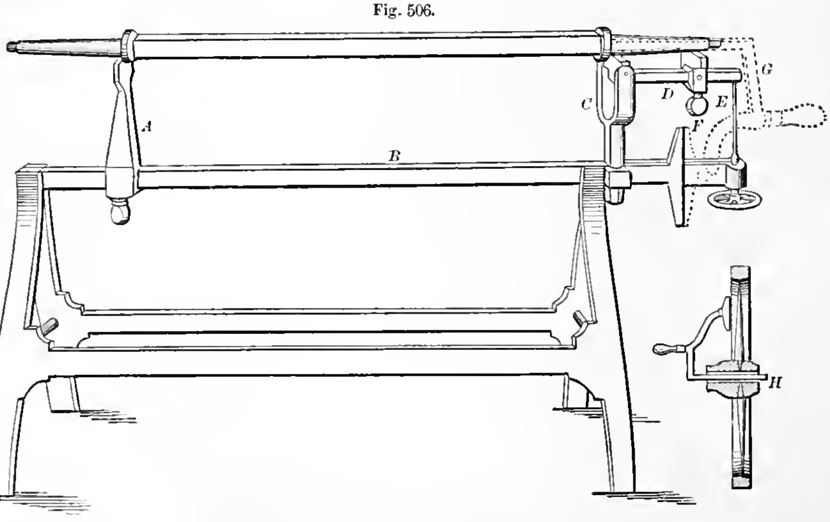
Fig. 505.



Foster's Machine for making Carriage-Axles.

Ax′le-mak′ing Ma-chine′. In FOSTER'S *Machine for making Carriage-Axles,* a bar of metal is fed into the machine and automatically formed into axles, which are cut off as finished. Shaping rollers form the journal and taper the bar of the axle, and dies form the collar by lengthwise pressure of the bar. The rolls act simultaneously upon opposite sides of the bar, and have dies which act coincidently to shape, and sharp edges to cut off at the given length. A pair of rolls are arranged to act perpendicularly to the die-rolls and in concert therewith.

Fig. 506.



Gorton's Axle-setting Machine.

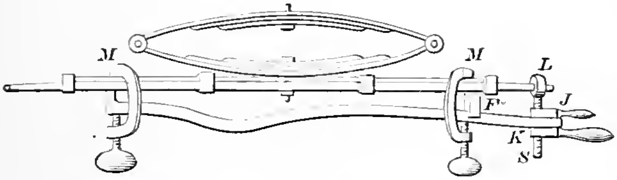
Ax'le-nut. A screw nut on the end of an axle-spindle, to keep the wheel in place. See NUT.

Ax'le-pin. A linch-pin, a fore-lock; a little bar passing through a mortise near the end of the *arm*, to hold the wheel thereon.

Ax'le-set'ting Ma-chine'. The *Axle-setting Machine* (Fig. 506) is for setting the spindles true on the ends of the axle-trees, giving them the required *set* and *gather*.

The uprights *A C* on the frame *B* are adjustable by set screws to any distance. The upright *C* has a jointed bar *D* projecting from it, which rests on a screw-rod *E*. This bar is a straight edge, to show the taper of the axle; for when the same is placed on the uprights, as shown in the engraving, and the stop *F* brought up to it by the screw, the taper will be given by the gage *G*, shown in dotted lines. If the axle does not touch the stop *F*, it is too high on the end, and must be brought down by the blacksmith. If it touches at the end and not at the shoulder, it is too low, and must be treated accordingly. The axle is then turned end for end, and the operation is repeated. The T-end on the frame is to set the T-foot of the gage against, as shown. The angle of the gage is obtained by setting the gage-foot against the spoke, and putting the straight edge *H* in the axle-box, as in the smaller figure.

Fig. 507.



Axle-Adjuster.

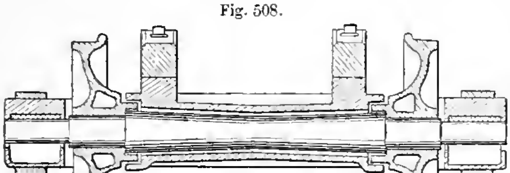
A more portable form of the same general character is shown in the *Axle-Adjuster* (Fig. 507). It consists of a bar hooked on to the axle-tree in two places.

The bar is fastened by clamp *M* and fulcrum-block *F*. The eye-bolt *L* is hooked over the end of the spindle, and the adjustment of the latter is accomplished by the screw *S* and set nuts *J K*.

Ax'le-skein. A band, strip, or thimble of metal on the wooden *arm* or *spindle* of a carriage-axle to take the wear from the wood.

Ax'le-sleeve. One placed around a railway-

Fig. 508.



Axle-Sleeve.

car axle in order to hold up the broken ends if the axle should be fractured.

Axle, Tel-e-scop'ic. An extension axle to allow the running wheels of a carriage to be slipped in or out to adapt them to varying gages of tracks.

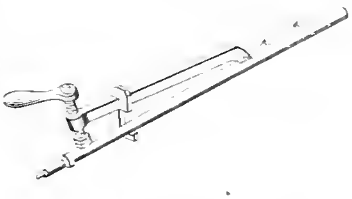
Ax'le-tree. The axle, or transverse bar, on whose ends the wheels of a vehicle are secured.

The term "tree" indicates that it was originally of wood, and is applied as a suffix to many words, such as *Bridge-Tree*, *Single-Tree*, *Double-Tree*, *Boot-Tree*, *Chess-Tree*, *Saddle-Tree*, etc. See AXLE.

Jones's axle-trees (*English Patent*) are made of wrought-iron, with pieces of steel welded beneath them near the ends so as to form the spindles. In hardening, the work is heated by a forge fire, a quantity of prussiate of potash mixed with carbonate of ammonia is dusted upon the metal, which is then plunged into the cooling tank, water being allowed to run upon it from a cistern. The prussiate of potash case-hardens the iron. The wheels are on the wrought-iron suspension-principle, having chilled-iron hubs.

Ax'le-tree Clamp. A tool for giving the proper pitch to a new axle-spindle, or for straightening one which is bent.

Fig. 509.



Axle-Tree Clamp.

Ax'min-ster Car'pet. A carpet with a flax or jute chain and a woolen or worsted filling which is formed into a pile.

The patent Axminster carpet, as made at Glasgow, is made first as a woven fringe, which is afterwards adapted to a thick flax backing.

The carpet is named from the town of Axminster, Devonshire, England, where the manufacture was formerly carried on. It has been discontinued at that place. It is of the Turkey variety. The linen chain or warp is placed perpendicularly between two rolls or beams, one of which carries the warp, and the other the finished carpet. Small tufts or bunches of different colored worsted or woolen are tied to or fastened under the warp; and when one row of these tufts has been completed, a linen weft thread is thrown in and firmly rammed down. Another row of tufts is then knotted in, the selection of colors being such as to carry on the pattern. To guide the weaver as to the position of the colors, a paper design constantly hangs before him. The linen chain and weft are entirely concealed.

Ayr Stone. A Scotch stone, called "Water of Ayr," used as a whetstone and in surfacing metals previous to polishing.

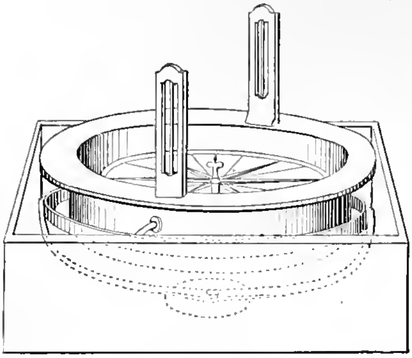
Az'i-muth Cir'cle. The azimuth circle, as an astronomical instrument, is used for determining the azimuths of stars. The azimuth is an arc of the horizon intercepted between the meridian of the place of the observation and the vertical circle passing through the object.

Az'i-muth Com'pass. This compass is graduated in degrees instead of being divided by *rhumbs*, like the *Mariner's Compass*. It has sights to allow the angles to be taken more accurately, and is designed to show the bearing of objects in respect to the magnetic meridian.

By a comparison of the magnetic azimuth of a heavenly body with the true azimuth as found by calculation, the variation of the needle is determined.

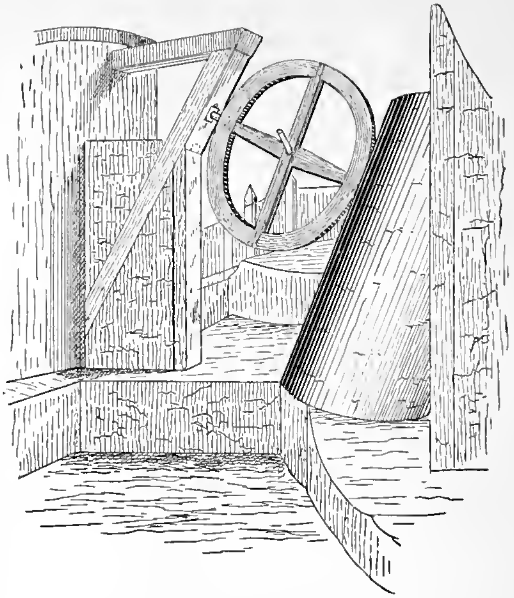
The instrument is shown in the accompanying figure. The sight-plates ascend perpendicularly, and their slits are bisected by a perpendicular thread or wire, serving as sights.

Fig. 510.



Azimuth Compass.

Fig. 511.



Brass Azimuth. Benares.

The ring of the gimbals rests with its pivots on the semicircle beneath, the foot of which turns in a socket; so that, while the box remains steady, the compass may be turned around so as to bring the sights into coincidence with the sun or other object observed.

The pivots of the gimbals, in this as in steering-compasses, should lie in the same plane as the point of suspension of the needle, so as to diminish the irregular vibration as much as possible.

In the inside of the compass-box lines are drawn perpendicularly down from the points where the sight-threads meet the sides of the box. These indicate the number of degrees, and parts of a degree, which the object bears from the magnetic north or south, on which account the middle of the apertures of the sight-vanes, the threads, and the above-mentioned lines should be exactly in the same vertical plane at the time of reading off the observation.

On one side of the compass-box is usually a nut or stop, which, when pushed in, arrests the vibratory motion of the card while the observer is noting the reading.

Az'i-muth Cir'cle. The cut (Fig. 511) illustrates an equatorial dial, according to Dr. Hooker probably a *Kranti-urit*, or azimuth circle, in the observatory at Benares, built by Jey-Sing, Rajah of Jayanagar, upwards of 200 years ago.

Dr. Hooker describes the astronomer-royal at the time of his visit as a "pitiful object," half naked, with a large sore on his stomach, who represented himself as being very hungry. Science, it would seem, has not been properly appreciated in that vicinity since the decline of the Mohammedan power. See Dr. Hooker's Himalayan Journals, London, 1855.

The equinoctial and equatorial sun-dials of Benares are considered under DIAL, where it will be seen that the former has a gnomon 30 feet long, and is ascended by steps; each quadrant is nine feet long. The fact of the ascent by steps throws interesting light upon the passage in the Second Book of Kings, chap. xx., where the "dial of Ahaz" (742 B. C.) is referred to. White says that the Hebrew word signifies a staircase, and in this form doubtless were the dials of the Mesopotamian nations, and that seen at Damascus by Ahaz, and afterwards copied by him in the one set up in Jerusalem. See ASTRONOMICAL INSTRUMENTS, where the large dial of Benares, referred to by Dr. Hooker, is shown on the elevated terrace on the left. Very remarkable and interesting are these relics which carry us back to the old times when, and the old means whereby, the astronomers of Chaldea and Egypt observed the heavens. When we consider their great discoveries, and recollect that they were destitute of lenses, as well as of means for minute and accurate graduation of instruments, we may well hold them in high respect. See ARMIL; ARMILLARY SPHERE.

The sun-dial of Delhi was also used as an observatory, and is described by White, of the East Indian Military Staff, as "a large circular building, having a number of openings or windows in the walls, and a pillar or gnomon in its center. Each of these windows had an appropriate astronomical term, and at night the position of the heavenly bodies was defined by the window or house in which it might be seen by a person stationed at the pillar; and during the day the time was regulated from the particular window through which the sun shone on the gnomon." The gnomon cast a shadow on the circular wall, which was graduated for that purpose. See DIAL.

The *gnomon* erected by the astronomer Uleg Beg, in 1437, at Samarcand, had a hight of 175.89 feet.

Az'i-muth Di'al. An azimuth dial is so called because the shadow marks the sun's azimuth. The stile, or gnomon, is perpendicular to the plane of the horizon.

Azogue. A Spanish ship fitted for carrying quicksilver.

B.

Bab'bitt-met'al. An alloy, consisting of 9 parts of tin and 1 of copper, used for journal-boxes; so called from its inventor, Isaac Babbitt, of Boston (patent, 1839). Some variations have been made, and among the published recipes are

Copper	1	1
Regulus of antimony	1	5
Tin	10	50

Another recipe substitutes zinc for antimony.

The term is commonly applied to any white alloy for bearings, as distinguished from the *box-metal* or *brasses* in which copper predominates.

Bab'bitt-ing-jig. (*Machinery.*) A tool used in babbitting the shafts and journals of machines. It holds the parts — of a harvester, for instance — in their respective positions, and also in proper relation to their boxings, so that the anti-friction metal may be run around each of the journals in succession.

Ba'by-jump'er. A cradle, basket, or sling in which a child is suspended. The suspensory cord is usually adjustable as to length, and, being elastic, permits a saltatory motion.

Ba'by-walk'er. A go-cart. A frame traveling on casters, and used to support an infant while learning to walk.

Bac. 1. (*Nautical.*) A broad, flat-bottomed ferry-boat, adapted for conveying horses and carriages, and usually navigated by a rope fastened on each side of the stream.

2. (*Brewing.*) A cistern with a perforated metallic bottom, used for straining the hops from the beer previous to its entrance into the cooler. Also written *back*.

Back. The part of an object against which the back of a person leans, as of a chair, carriage, etc.

The rear portion of an object.

The upper part of a thing, as of an arch, hand-rail, saw, etc.

1. (*Forging.*) A cast-iron plate forming the back-wall of a forge, and through which the blast enters by a *tuyere*.

When the back consists of an iron cistern, it is called a *water-back*.

When it consists of a chamber in which the air-blast is heated, it is a *heating-back*.

2. (*Bookbinding.*) The part to which the sides of the cover are attached, and which receives the lettering.

3. (*Architecture.*) *a.* The rear surface of a wall.

b. The rear wall of a fireplace.

c. The extrados of an arch or vault.

d. The rear part of a stone or ashlar, parallel with the *face* or exposed surface.

4. (*Cork-cutting.*) The burnt side of a slab of cork.

5. (*Brewing, etc.*) A vat or cistern.

a. *Water-back:* a supply cistern in a brewery, etc., containing water for mashing.

b. *Under-back:* a cistern below the *mash-tun*, which receives the *wort* therefrom.

c. *Hop-back:* a cistern below the copper, which receives the infusion of malt and hops from the latter.

d. *Jack-back:* the same as *hop-back*.

e. (*Glue-making.*) *Settling-back:* a cistern in which a solution of glue from the kettle is received and kept warm till the impurities have time to settle.

f. (*Distilling.*) *Wash-back:* a cistern or vat in which the *wort* is fermented to form *wash* for distillation.

g. *Spirit-back:* the cistern which receives the spirit.

In this sense the word is nearly allied to *beck;* as a *dye-beck* or *soap-beck* in a dye-house. See BECK.

6. (*Carpentry.*) *a.* The upper surface of a hand-rail; the under side is the *breast*.

b. The same distinctions apply to the ribs of domes and rafters of roofs.

c. The *back* of a window is the wainscoting below the sash-frame and extending to the floor.

d. The upper edge of a saw as opposed to the edge which is serrated.

7. (*Mining.*) *a.* The part of a lode nearest to the surface.

b. The ground between one level and another is the *back* of a level.

8. (*Shipbuilding.*) *a.* The convex surface of a compass-timber.

b. Figuratively, the keel and keelson of a ship.

c. A timber bolted on behind the sternpost.

9. (*Nautical.*) *a.* *To back an anchor:* to place a small auxiliary anchor ahead of the one from which the ship rides.

b. *To back a sail:* to brace a yard so that the wind blows in front of it.

c. *To back astern:* to give the vessel sternway.

d. *To back a rope:* to put on a *preventer* to take a part of the strain.

e. *To back the worming:* to fill the crevices between the strands, to bring the surface flush and even, ready for *serving*.

Back-ac'tion Steam-en'gine. One in which the connecting-rod, pitman, and crank are so arranged as to take up but little longitudinal space. The cross-head on the end of the piston-rod is connected by parallel side-bars to a cross-tail, which, by a backwardly reaching pitman, is connected to the crank of the propeller engine. One of the side-bars passes above the crank, and the other below it. Being used for propeller engines, the crank and shaft must be amidships and the engine and appurtenances lie upon the floor athwart-ship. "Juniata" and ten sister vessels of the United States navy are of this class.

Back-bal'ance of Ec-cen'tric. (*Steam.*) The weight fixed to the back of an eccentric-pulley for the purpose of balancing the weight of the pulley on the shaft.

Back-bal'ance of Slide-valve. (*Steam.*) The weight fixed at the extremity of the valve-lever for balancing the weight of the slides.

Back-band. (*Saddlery.*) The band or strap which passes over the back of the horse and meets the belly-band; the two unite to girth the horse.

Back-cen'ter. (*Turning.*) The point on the *back* or *dead spindle* of a lathe which supports that end of the work. The front-center is on the *live-spindle* in the head-stock. It is set up by the *back-center screw*. See LATHE.

Back-cloth. (*Calico Printing.*) The cloth sustaining the fabric in one form of calico printing.

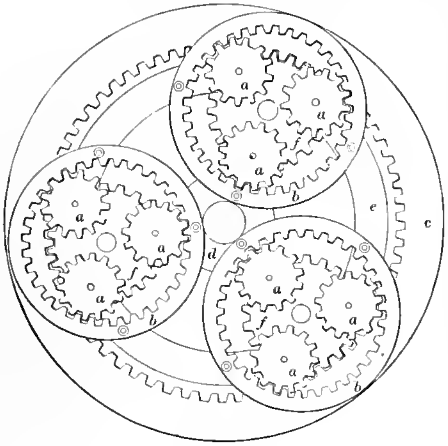
Back-cut'ting. (*Civil Engineering.*) Earth obtained for a canal bank, when the excavated earth does not suffice.

Back'er. (*Slating.*) A narrow slate laid on the back of a broad, square-headed slate, at the spot where a course of slates begins to diminish in width.

Back-flap. (*Joinery.*) The leaf of a window-shutter which folds inside the casing, and is concealed when closed.

Back-frame. (*Rope-making.*) A wheel for turning the *whirlers* of a rope-making machine. The whirlers, to which the ends of the strands are connected, are stocked in the centers of the pinions *a a a*, which roll around inside the internally geared ring *b*, as the frame *c d* rotates. The frame *c d*, with its three annular gears *b b b*, and their respective

Fig. 512.



Back-Frame.

wheels *f a a a*, are revolved so that the wheels *f* mesh with the internal cogs of the annular gear *c*, causing the wheels *a a a* of each system to rotate on their axes, and thereby twist the yarns into strands; to *revolve* around each other, and thereby lay up their three strands into a rope; while, at the same time, the three systems revolve around each other, and lay up the three ropes into a hawser or larger rope.

Back-gam'mon. A game of chance and skill, played by two persons, with fifteen men each upon a board having twelve black and twelve red *points*. It is a Welsh game, and is said to have an antiquity of a thousand years. Rameses and his ladies played checkers. Chess came from India; so did cards.

Backgammon is mentioned by Chaucer, Shakespeare, and Bacon as "playing the tables,"—a name by which it was then known.

Back-gear. (*Turning.*) The set of variable speed gear-wheels in the headstock of a power-lathe.

Back'ing. 1. (*Masonry.*) The coursed masonry next to the extrados of an arch, and resting thereon.

2. (*Fabric.*) The web of coarser or stronger material at the back of such goods as velvet, plush, satin, Brussels carpet, etc.

3. (*Printing.*) Printing the second side of a sheet.

4. (*Type.*) Filling in the back of an electrotype. See BACKING-UP.

5. (*Ship.*) The rear support of an armor-plate. This is of timber, from twice to four times the thickness of the armor, with or without an inner skin, about one eighth the thickness of the armor-plates; sometimes supported by vertical frames.

Compound backing consists of alternate layers of wood and iron, in the usual proportion of $4\frac{1}{2}$ wood to $\frac{1}{2}$ plate-iron. See ARMOR-PLATING.

Back'ing-boards. (*Bookbinding.*) Those between which a *book* is grasped to be laid in the press while the back is rounded. See CUTTING-PRESS.

Back'ing-ham'mer. (*Bookbinding.*) The bookbinder's hammer for rounding the back of a book.

Back'ing-off. (*Spinning.*) The retrograde motion of the mule when it recedes from the creel and draws the yarn from the spools. Its *putting, running-in*, or *going-in*, is the motion towards the creel when the winding takes place on the spindles of the mule. See MULE.

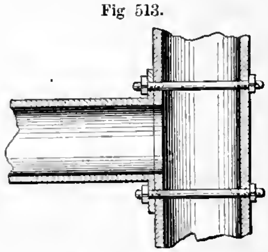
Back'ing-up. 1. (*Engraving.*) Removing a hollow or mark from the face of a plate by blows from the peen of a hammer applied to the back, the face being laid on an anvil or stake. This mode is used by engravers in obliterating lines too deep to be treated by the scraper or burnisher.

2. (*Type.*) The process of fortifying with type-metal the back of the thin electrotype plate which has been deposited on the face of the mold obtained from the *form* of type.

The back of the copper shell receives a thin coating of tin, and is then placed face downward in a shallow iron dish in which it is secured by rods. The dish is then suspended from a crane and swung over a bath of molten metal. When it has acquired the temperature of the bath, a quantity of type-metal is dipped up and poured over the back of the copper plate, forming a solid backing. A planing-machine reduces the backing to an even thickness, bringing the whole to a thickness of say one seventh of an inch.

Back'ing-up Flange. (*Machinery.*) A collar on a pipe by which the latter is held to its bearings or seat.

Fig 513.



Backing-up Flange.

Back-joint. Such a one as that formed by a rabbet on the inner side of a chimney-jamb to receive a slip.

Back-lash. The reaction or striking back of a piece of machinery, wheel, piston, etc., when the power makes a temporary pause, or a change of motion occurs. It is a consequence of bad fitting or wear, and, in the latter case, indicates that the parts should be *set up*. The gib, cotter, and strap of the pitman connection are an instance of provision for said readjustment.

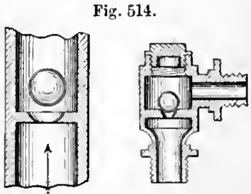
In some cases springs are arranged to keep the parts in positive contact, so that no reflex motion occurs, to be taken up suddenly when the power is again applied.

Back-link. (*Steam-Engine.*) One of the links in a parallel motion which connect the air-pump rod to the beam.

Back-pup'pet. (*Lathe.*) The standard which holds the back-center of a lathe on which one end of the work rests. See LATHE.

Back-pres'sure Valve. (*Hydraulics.*) A ball or clack-valve in a pipe, which instantly assumes its place upon its seat when a reflex or back pressure occurs.

Fig. 514.



Back-Pressure Valve.

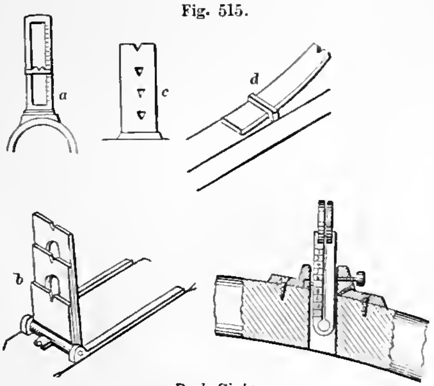
The figure with the arrow shows the normal condition; the other figure shows the valve on its seat.

Back-rope. (*Nautical.*) One of the ropes connecting the lower end of the *dolphin-striker* with the ship's head.

Back-saw. A saw whose web is stiffened by a metallic back of greater substance; as, a tenon saw.

Back-sight. 1. (*Fire-arms.*) The rear sight of a gun. It may be of various forms. In the old-fashioned arms intended for round balls, it was merely a notch in a knob or plate near the breech of the gun, the proper elevation to be given being estimated by the marksman. As the effective range scarcely exceeded 250 to 300 yards, this could be done with sufficient accuracy by an expert marksman; but with the introduction of the elongated bullet, giving ranges of 1,000 yards and upward, it became necessary to seek some more efficient means of securing the proper range at these long distances, so that the bullet might not either pass over or fall short of the object. For this purpose was introduced

Fig. 515.



Back-Sights.

the rear-sight (*a*, Fig. 515), consisting of an upright slotted branch, which was jointed to a seat on the barrel of the gun, or, in some instances, on the small of the stock in rear of the barrel. A notched slider on the upright branch could be elevated as desired, and by elevating the muzzle of the gun until this notch and the front-sight were in line, any range within the limit of projection of the piece could be attained.

This sliding sight has, in the United States service, been superseded by the leaf-sight (*b*, Fig. 515), which is more compact and less liable to derangement. Also called *Folding-Sight.*

Other back-sights, especially those first introduced in Southern Germany, have been made very different in form from those described; one variety (*c*, Fig. 515) being permanently fixed perpendicularly to the barrel, and having notched holes at proper hights through which to sight, and another (*d*, Fig. 515) being segmental in shape, and moving circularly in a direction longitudinal to the barrel through a stud fixed thereon.

Another form of back-sight (*e*, Fig. 515) vertically adjustable for range, and attached to the stock, has a graduated spring-piece slipping within a vertical slot in the small of the stock, and is adjusted as required. Its spring retains it in place, or it may be clamped by a set-screw or lowered below the line of the hind-sight on the barrel.

2. (*Leveling.*) The reading of the leveling-staff; taken back to a station which has been passed. Readings on the forward staff are *fore*-sights.

Back-staff. (*Optics.*) A peculiar sea-quadrant, invented by Captain Davis, 1590. It has a graduated arc of 90° united to a center by two radii, with a second arc of smaller radius, but measuring 6° on the side of it. To the first arc a vane is attached for sight; to the second, one for shade; at the vertex the horizontal vane has a slit in it. The back of the observer is turned towards the sun at the time of observation. (*Admiral Smyth.*)

It is now superseded by instruments of more modern type, such as the reflecting quadrant and sextant.

Back-stay. (*Shipbuilding.*) One of the guy-ropes, just abaft the shrouds, extending from all topmast-heads to the sides of the ship, to stay the masts. They are attached to *back-stay stools*, which are detached channels or chain-wales.

Back-strap. (*Saddlery.*) The strap passing along the back of the horse.

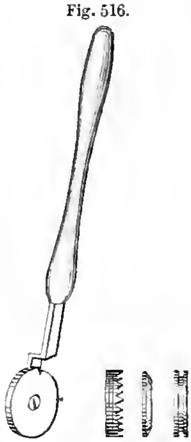
In wagon harness it extends from the upper *hame-strap* to the *crupper;* or, in the absence of a crupper, to a point of junction with the hip-straps.

In carriage harness it extends from the *gig-saddle* to the *crupper.*

Back-sword. A sword with one sharp edge, in contradistinction to one which has two edges throughout the whole or a portion of its length.

Back-tool. (*Bookbinding.*) A fillet, roller, or other hand-tool for dry-tooling or gilding the backs of books.

Fig. 516.



Back-Tool.

Back'wa-ter. (*Hydraulic Engineering.*) Water reserved at high tide for scouring a channel or harbor by discharge at low-tide. See FLUSHING.

Bad'ger Plane. (*Joining.*) A *panel plane* whose mouth is cut on the skew, and from side to side, so as to work up close to a corner in making a *rabbet* or *sinking.*

Ba-dig'eon. A cement for stopping holes and covering defects in work.

Statuary's: plaster and free-stone.

Joiner's: sawdust and glue; whiting and glue; putty.

Cooper's: tallow and chalk.

Stone-mason's: wood-dust and lime slaked together, with stone-powder or sienna for color, and mixed with alum-water to the consistence of paint.

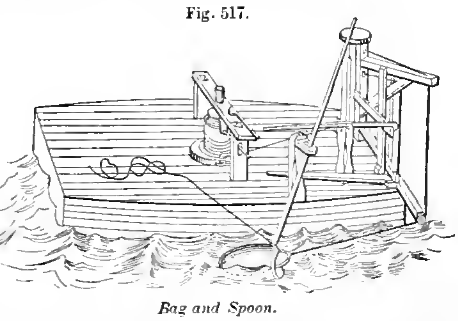
Ba'e-tas. (*Fabric.*) A plain unchecked woolen stuff, manufactured in Spain and Portugal.

Baft, Baft'as, Baf'fe-tas. (*Fabric.*) *a.* A blue or white cotton goods, used in the African trade.

b. A kind of East Indian cotton piece-goods.

Bag and Spoon. (*Hydraulic Engineering.*) An implement used in dredging for river sand.

Fig. 517.



Bag and Spoon.

It is a hoop of iron with a steel lip, and has one edge pierced with holes, for the attachment of a leather bag by lacing. The spoon is suspended by a chain, and has a long handle by which it is guided.

Being sunk in position, it is drawn along the bottom, hoisted by a crane, and dumped into a lighter or mud barge. The bag is perforated for the escape of water. The cut shows the bag overboard, and about to be sunk to the bottom by means of the pole.

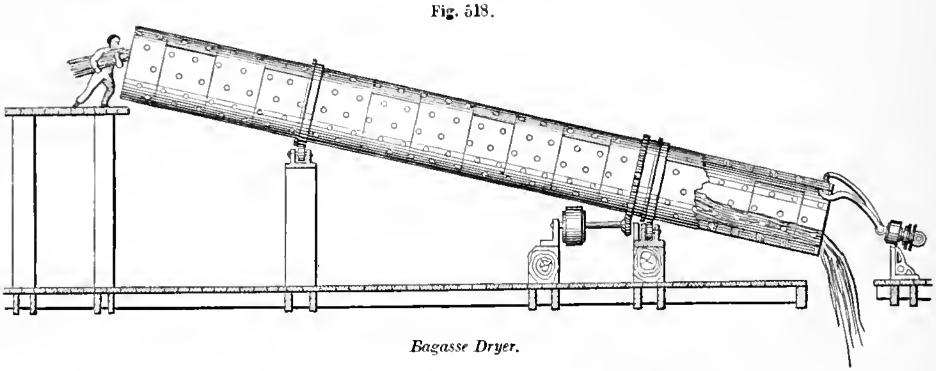
Ba-gasse′ Dry′er. Bagasse is crushed cane as it comes from the mill, deprived, to a great extent, of its juice and saccharine matter; also of the leaves, which are stripped from it previous to grinding. According to Wray, good mills only extract from 70 to 75 per cent of the saccharine matter which analysis shows to be present in the cane, and the remainder, after the water is evaporated, joins with the fiber and other carbonaceous matters to form a fuel, coal and wood being very expensive in sugar-cane regions.

The bagasse is sometimes carted to the field, to be dried by the sun, but a number of United States patents have been granted for apparatus for drying it by artificial heat. Other furnaces are constructed merely for burning it to get rid of it. Vast piles of it accumulate round the mill-houses.

In MERRICK's patent of April 10, 1845, the bagasse is transferred to an inclined chute, whence it is taken by an endless apron, which passes around reels or drums, and conducts it through a series of three heated compartments, finally depositing it on a plate or platform in front of the furnace, or other convenient position.

Another form of the Bagasse Dryer consists of an inclined open-ended cylinder, having a steam jacket and hollow bolts, through which escapes the water evaporated from the cane. The steam is introduced through hollow trunnions, and the dryer-tube is rotated by pinion and annular gear, as shown in the figure. The material is fed in at the upper end, and works gradually to the lower end, where it forms a

Fig. 518.



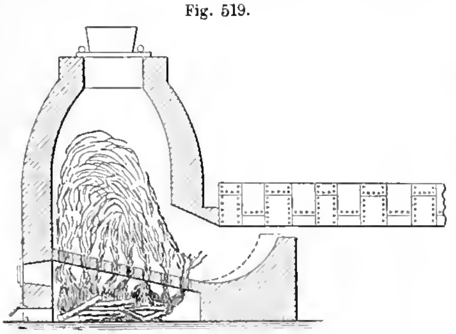
Bagasse Dryer.

pile of dry stuff, and is forked into the furnace beneath the sugar-pans and the engine which runs the establishment.

Ba-gasse′ Fur′nace. A furnace for consuming the bagasse (or megass), the cane remaining after the pressure of the saccharine juice therefrom. It generally consists of a kiln or large chamber with a flue to the furnace-space beneath the boilers which make steam for the cane-mill.

The principal reason for burning it is to get rid of it, as it accumulates around the sugar-house and

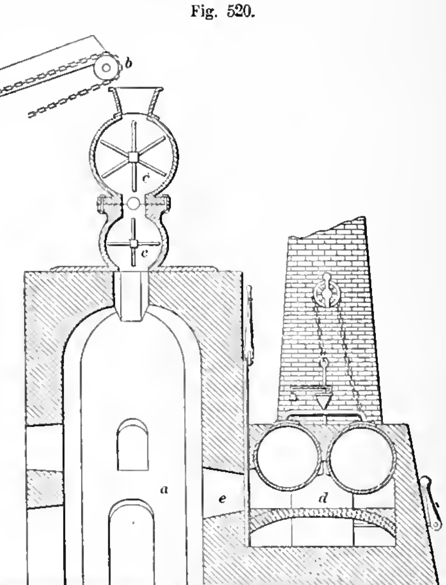
Fig. 519.



Bagasse Furnace.

becomes quite a nuisance. By dint of making a roaring fire, it may be consumed, and perhaps add something more to the fire than it subtracts by the evaporation of its water. The example (Fig. 519) shows it as dumped in a pile upon the grating above the fire. The heat resulting from the combustion of the bagasse and fuel thence passes beneath the boilers which drive the sugar-mill, and, in some sugar-

Fig. 520.



Bagasse Furnace.

houses, heat the vacuum-pans, defecators, surface-evaporators, and run the pumping-engines.

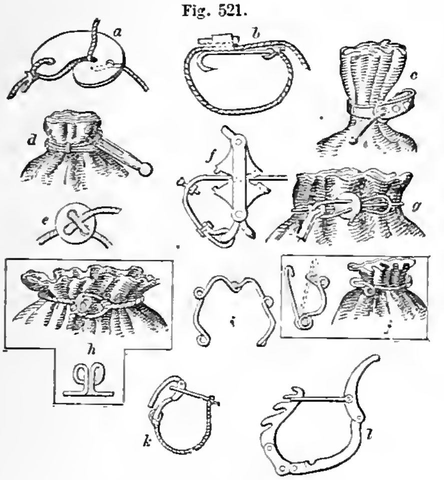
Fig. 520 shows a furnace for burning the cane-refuse, and the relation of the furnace proper *a* to the discharge-apron *b* of the cane-mill, the feeding devices *c c* and the furnace *d*, of the steam-boilers. The bagasse does not pass beneath the boilers, but the flame of the furnace *a* is carried into *b* through the flue *c*, and additional air is admitted beneath the grating of *d* by dampers in the ash-pit.

Bag-clasp. A clamp or cincture for closing the mouths of bags. See BAG-FASTENER.

Bag-fast'en-er. A device for clamping or tying the mouths of bags below the hem. A substitute for a bag-string.

A number of different modes are shown in the illustration, and will be briefly described.

Fig. 521.



Bag Fasteners.

a. A sheet-metal tag, with a curved tapering slot, is permanently attached to one end of the string. The other end of the string becomes jammed in the slit.

b. The metallic tag attached to one end of the string has a thimble in which the other end of the string is jammed by a wedge.

c. One end of the string has a permanent ring. The other end is rove through an eyelet in itself, and jams against the ring.

d. One loop is permanently attached to a slotted lever. The latter is rove through the other loop and turned over beyond the dead-center, so as to jam the loop against the standing part.

e. The standing end is rove through two holes in the tag, and forms a loop which jams down upon the point end of the cord.

f. The point end is jammed between two pivoted, cogged sectors.

g. The perforated leather tag is riveted to the bag, and the thong is rove through the holes so as to bind tightly.

h. One end of the cord is knotted to the loop of the wire. The other end is passed round the bag and jammed between the jaws.

i. A pair of hinged clasps whose free ends interlock.

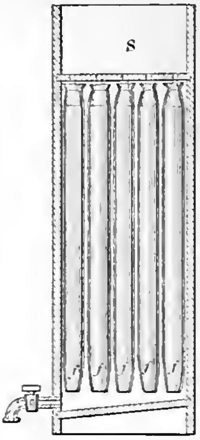
j. A spring device, acting in the manner of a brooch; a spring pin engaging a catch.

k. A lever attached to one end of the cord engages a loop on the other end, and is thrown over to carry the loop to a curved portion, which holds it securely.

l. Similar to the last, but having a means of adjustment.

Bag-fil'ter. (*Sugar-Refining.*) A device sometimes used in clearing saccharine solutions of feculencies and impurities mechanically suspended therein.

Fig. 522.



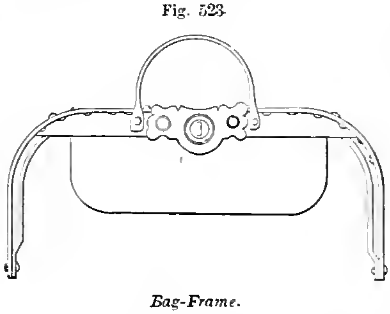
Bag-Filter.

In one form the juice is allowed to pass through a series of copper-wire sieves of gradually increasing fineness before reaching the flannel bag; perhaps the more usual form is that in which the sieves are replaced by the series of vertical flannel strainers arranged in a lower chamber, having a stopcock, into which the juice is admitted from a compartment above.

The example consists of a sirup-cistern *S*, in whose floor are short pipes of conical form, to which flannel bags *f* are tied. The juice, passing down each of the pipes, distends the bags, and drips down their outer surfaces, collecting in the chamber below, whence it is drawn by a faucet.

Bag-frame. The metallic frame to which the leather or cloth part of a carpet-bag or valise is secured, serving to impart stiffness and afford means of attachment for the handle and lock.

Fig. 523.



Bag-Frame.

Bag'gage-check. A tag or label to be attached to a trunk, to indicate its destination; usually, also, its point of departure, and frequently the name of the railway company attaching the said check.

The devices are numerous.

a (Fig. 524) shows a check or label-holder of two metallic portions which form a frame for the inclosed card, on which is inscribed the name of the place of destination. This is used also for mail-bags.

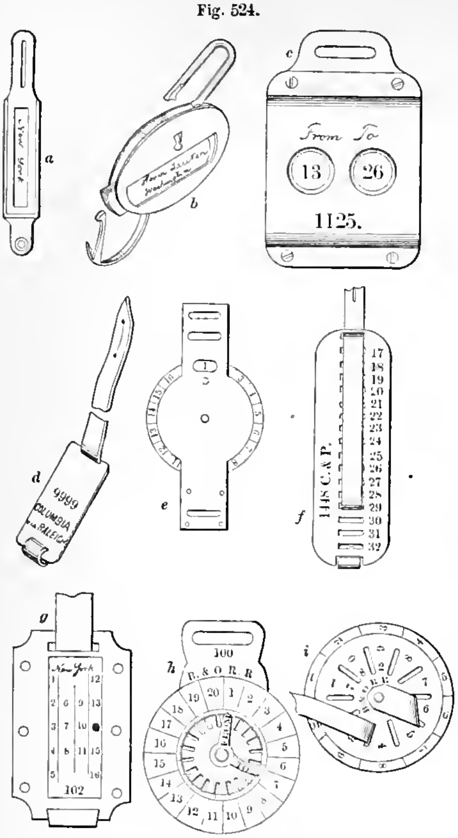
b is a lock-up case for a number of such cards, either of which is exposed at the opening as may be required.

c has two series of numbers on wheels, and the places of departure and destination are indicated by numbers agreeing with the schedule of stations.

d has the places of departure and destination on the respective sides. Either of the readings may be hidden by the strap which is rove through the loop at the other end from that of its attachment to the check. On the return trip, the other side of the check is exposed by the inverse reeving of the strap.

e has a disk with a circumferentially numbered margin. A number agreeing with the schedule-number of the station for which the baggage is bound is exposed at the opening in the plate. By an arrangement of the strap, the latter is made to hold the disk, so as to secure the required presentation of figure.

Fig. 524.



Baggage-Checks.

f has the series of station-numbers in a row; the strap is so rove through the slots as to indicate the station (29) at which the baggage is to be put off.

g is a metallic case inclosing a card with the numbers of the stations printed thereon. A punch-mark indicates the station of destination (14 in the illustration). The strap holds the parts of the case together, being rove through the loops.

h has a dial-plate and pointers, which indicate the station of departure and destination.

i is a metallic disk with radial slots and corresponding numbers. The strap is so rove through the slots as to give the required indication.

Bag'ga-la. (*Nautical.*) A two-masted Arabian vessel, frequenting the Indian Ocean. A *dhow*. The capacity is from 200 to 250 tons.

Bag'ging. (*Fabric.*) 1. A coarse fabric made of old ropes, hemp, etc., for covering cotton-bales.

2. The gunny-cloth of India is made from jute. In Bengal, from one or two species of *Corchorus;* in Bombay and Madras, from the *Crotalaria juncea.*

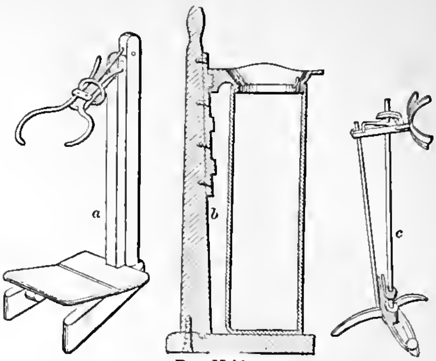
Bag-hold'er. A contrivance to hold up a bag with the mouth open ready for filling. There are many forms, — some adapted for large grain-bags, others of a smaller size for flour, seeds; still smaller, for ordinary groceries and counter use.

a has a platform on which the sack stands, and its weight spreads the horns within and distends the mouth of the sack.

b has a holder adjustable as to hight, and a hopper to which the mouth of the bag is attached.

c has clasping bars operated by a foot-trigger.

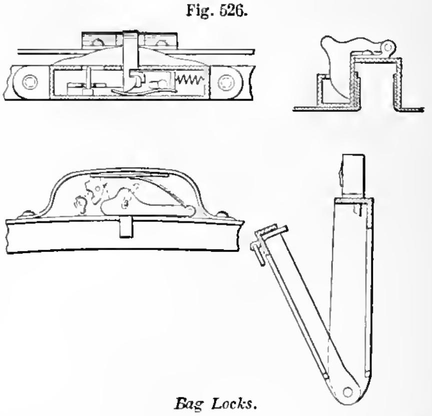
Fig. 525.



Bag-Holder.

Bag-lock. *a.* A peculiar form of lock, used for satchels, etc., frequently merely a padlock. There are many varieties, — snap-latches, clasps, thumb and key bolts, etc. In the illustration are shown several varieties, which do not require explicit description.

Fig. 526.



Bag Locks.

b. A lock for mail-bags, usually some form of padlock, seal-lock, or shackle.

Bag-ma-chine'. A machine for making bags of paper or textile fabric. The term is usually applied to machines which make paper-bags for salesmen's and domestic uses. In some of these the paper is handled as in an envelope-machine, blanks of a certain size and shape being previously cut out; these are fed one at a time to the machine, either automatically or by hand, and are gummed, folded, and delivered in a pile. In other machines, the paper is made up into a hollow tube, like a stove-pipe, and is fed to the machine which makes an oblique cut, forming a flap which doubles over to close the bottom of the bag at a subsequent operation. See PAPER-BAG MACHINE.

Looms are constructed specially for making seamless bags, having a circular *shed* for that purpose. After making the length of two bags, the sheds are united, so that the tubular portion is closed and a single web of double thickness is formed. A couple of inches of this is enough, and by a transverse midway cut this double portion, thus divided, forms the closure of two bag-bottoms. The double bag-length of the tubular portion is also transversely divided midway, the cut forming the mouths of two bags.

Bag-net. (*Fishing.*) A landing-net, or net bag-shaped, for sweeping a stream, or to be set in a stream to catch fish.

Bag'nette. (*Architecture.*) A small molding, like the astragal. When enriched with foliage, it is called a *chaplet;* when plain, a *head.*

Bag'pipes. An ancient Greek and Roman instrument. The leathern bag receives air through a valved tube from the lungs or a bellows, and is squeezed by the arm to drive the air into the pipes, which are operated by the performer. The *bass* pipe is called the *drone*, and the *tenor* or treble pipe the *chanter.* It is now considered a Scotch or Irish musical instrument, though Nero is reported to have solaced his gentle mind with its strains. Formerly common throughout Europe, it is now nearly restricted to Scotland, Ireland, parts of France, and Sicily.

It is the common country instrument of the Punjaub. The Sikh instrument rather resembles the Italian *pfifferari* than the pipes of the Scottish Highlanders.

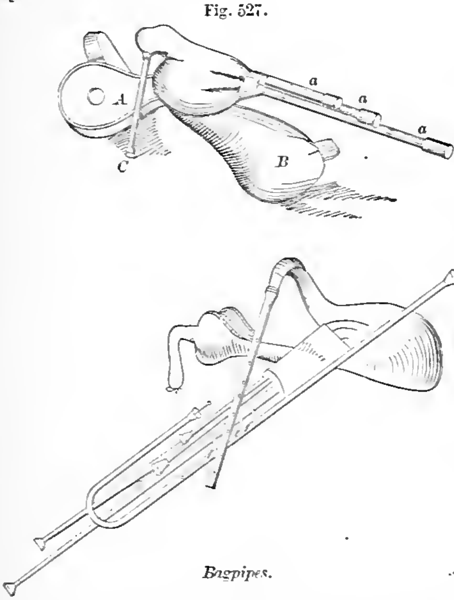
"After dinner we had a fellow play well upon the bagpipes, and whistle like a bird exceeding well." — *Pepys's Diary*, May, 1661.

Its notes are remarkable for power rather than sweetness, and require uncommon skill in the performer to render them even moderately pleasing to a cultivated ear, unless from the force of habit or the associations connected with the instrument. *De gustibus non est disputandum*, — the Romans flavored their sausages with asafetida.

Pipers are still attached to the Highland regiments in the British service.

The antiquarian notices of the instrument are in the *Musurgia* of Luscinius, 1536, and in "Don Quixote."

Fig. 527.



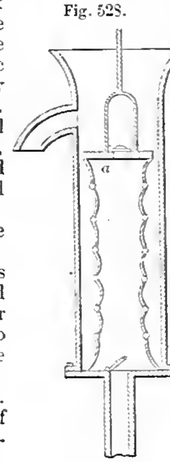
Bagpipes.

The Irish bagpipe was originally the same as the Scotch, but they now differ in having the mouthpiece supplied by the bellows *A*, which, being filled by the motion of the piper's arm, to which it is fastened, fills the bag *B*; whence, by the pressure of the other arm, the wind is conveyed into the *chanter* *C*, which is played on by the fingers like the common pipe. By means of a tube the wind is conveyed into drones *a a a*, which, being tuned at octaves to each other, produce a kind of cronan or bass to the chanter.

The lower cut represents the improved or union pipes, the drones of which, tuned at thirds and fifths by the regulator, have keys attached to them so as to produce chords, parts of tunes, or whole tunes, even without using the chanter. Both drones and chanter may be rendered quiescent by stops.

Bag-pump. (*Hydraulics.*) A form of bellows-pump in which the valved disk *a*, which takes the place of the bucket, is connected with the base of the barrel by an elastic bag distended at intervals by rings. It is described by Dr. Robinson in his "Mechanical Philosophy." It is much older, however, than this work, and has been invented again and again, from time to time.

Fig. 528.



Bag-Pump.

Bag-reef. (*Nautical.*) The lowest reef of a sail.

Bags. (*Porcelain.*) The flues in a porcelain oven which ascend on the internal sides and enter the oven at elevated points, so as to heat the upper part. See OVEN.

Bag-tie. See BAG-FASTENER.

Bag-weigh'er. A form of steelyard adapted for this purpose. See STEELYARD.

Bail. The arched handle of a kettle or bucket, to which it is usually connected by loops called *ears*, on the latter. The ends are usually bent around the ears, so as to be permanent, though loosely attached; but sometimes the bail is jointed, and adapted to be hooked to the ears as occasion may require.

The bails of common wooden buckets, such as are used in the house or sugar-camp, have their hooked ends inserted into perforated metallic plates, or *ears*, which are tacked to the staves.

The crane-ladle of the foundry has a *bail;* the smaller ladles have crutched handles.

Bails. (*Nautical.*) The frames that support the awning or tilt of a boat.

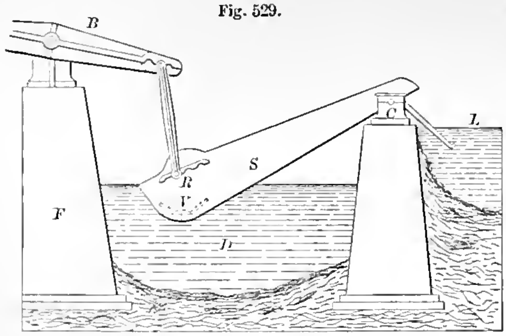
Bail-scoop. A scoop or pivoted trough, designed for draining bodies of water.

That shown in the cut was contrived by Mr. W. Fairbairn, and is adapted to be worked by the single-acting Cornish engine.

The scoop *S* turns on a center at *C*: its other end is connected at *R* to the end of the engine-beam *B*, supported on a suitable foundation *F*. *D* is the drain, and *L* the level of the water in the river or place of discharge. The stroke of the engine raises a weight suspended from the beam and depresses the end *E* of the scoop, into which water is admitted through the upwardly opening valves *V*. The weight then descends by its own gravity, elevating the immersed end of the scoop sufficiently to discharge its contents into the water at *L*. The dip may be regulated by shifting the connecting-rods.

The scoop is made of boiler plate-iron, and is 25 feet long and 30 wide, with two partitions across it to strengthen the sides and afford bearings for the valves. Seventeen tons of water can be raised at each stroke by this machine, and with an engine of 60-horse power it will do a duty equal to three pounds of coal per horse-power an hour.

Fig. 529.



Fairbairn's Bait-Scoop.

Bait-mill. A machine used by the "Bank" fishermen for cutting fish into bait. It is an oblong wooden box, standing on one end, and contains a roller armed with knives, and turned by a crank on the outside.

It resembles in form and operation a *sausage*-cutting machine, but delivers a coarser product.

Baize. (*Fabric.*) A coarse woolen fabric with a long nap, principally used for covering tables, screens, etc. First made at Colchester, England, in 1660.

"Bought me a new black baize waistecoate, lined with silk." — *Pepys*, 1663.

"Sir Thomas Clifford talked much of the plain habits of the Spaniards: how the king and lords themselves wear but a cloak of Colchester bayze, and the ladies mantles, in cold weather, of white flannell; and that the endeavours frequently of setting up the manufactory of making these stuffs there, have only been prevented by the Inquisition."—*Ibid.*, February, 1667.

Ba-la-lai'ka. (*Music.*) A musical instrument of the bandour kind, of very ancient Sclavonian origin. It is in common use both with the Russians and Tartars. According to Niebuhr, it is also frequent in Egypt and Arabia. The body of it is an oblong semicircle, about six inches in length, with a neck or finger-board of two feet. It is played on with the fingers, like the bandour or guitar, but has only two wires, one of which gives a monotonous bass, and by the other the air is produced.

Bal'ance. The word *balance* is applied to many things: some in reference to their resemblance to the oscillating beam of the scales, such as the *balance-beam* or *working-beam* of some forms of steam-engines; the *balance-handle* of a table-knife, which is weighted to lift the blade from the table-cloth; the *balance-beam* of a crane whose jib is poised on the post; the *balance*, or pivoted beam of one form of electrometer; the *balance-thermometer*, which is poised on a stem, and is thrown out of equipoise by fluctuations in the length of the column of contained mercury.

The *balance-cock* of a watch affords a bearing for the upper pivot of a watch-balance.

The *balance-plate* and *balance-ring* are parts for sustaining the upper pivot of a watch-balance. They differ in shape, but that is their function.

The *balance-spring* is the hair-spring which gives the recoil motion to the oscillating *balance-wheel*, whose pulsations determine the rate of movement of the timekeeper.

The *balance-verge* is the arbor of the balance, and carries the pallets which act upon the scape-wheel.

The *balance-weight* is a shifting weight to poise the balance, or a counterweight to balance the weight of other attached parts, as in the driving-wheel of a locomotive, etc.; or a weight to partially counterbalance the weight of a valve, and enable it to be lifted more readily.

The *electric balance* is a form of electrometer.

The *hygrometric balance* is a form of hygrometer, in which the absorption of moisture destroys the equipoise of a balanced beam.

The *hydrostatic balance* is a modification of the ordinary balance, for the purpose of obtaining specific gravities.

The *steam-balance* is the ordinary safety-valve which has a weighted lever. It was invented by the illustrious Dr. Papin, of Blois.

The *torsion-balance* is a delicate electrometer, in which a horizontal bar is suspended from a wire which is twisted by the magnetic attraction or repulsion.

The specific-gravity balance was due to the discovery of Archimedes.

The "Book of the Balance of Wisdom," by Al-Khâzinî, of the twelfth century, is a treatise on the specific-gravity balance, which he credits to Archimedes, narrating the story of Hiero and the Syracusan goldsmith; and which, as he says, "is founded upon geometrical demonstrations, and deduced from physical causes, in two points of view: 1. As it implies centers of gravity, which constitute the most noble and elevated department of the exact sciences, namely, the knowledge that the weights of heavy bodies vary in proportion to the differences in distance from a point in common, — the foundation of the steelyard; 2. As it implies a knowledge that the weights of heavy bodies vary according to difference in rarity or density of the liquids in which the body weighed is immersed, — the foundation of the balance of wisdom." The book of the Saracenic philosopher was translated by Chev. Khanikoff, Russian Consul-General at Tabriz, Persia; and an English translation is in the sixth volume of the "Journal of the American Oriental Society," New Haven, 1860.

In connection with the subject of the great relative weight and accepted theory of the value and purity of gold, the pious Moslem enters the following protest: —

"When the common people hear from natural philosophers that gold is the most equal of bodies, and the ore which has attained to perfection of maturity at the goal of completeness, in respect to equilibrium [stability of character, under circumstances which dissolve or destroy other metals], they firmly believe that it has gradually come to that perfection by passing through the forms of all [other] bodies, so that its gold nature was originally lead, afterwards became tin, then brass, then silver, and finally reached the perfection of gold; not knowing that the natural philosophers mean, in saying so, only something like what they mean when they speak of man, and attribute to him a completeness and an equilibrium in nature and constitution, — not that man was once a bull and was changed into an ass, and afterwards into a horse, and after that into an ape, and finally became man."

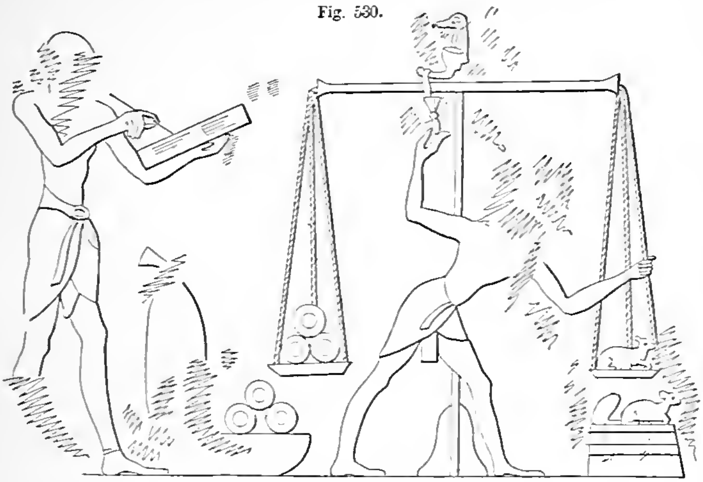
This has been wrongly quoted; it is not fair to call Al-Khâzinî a Darwinian.

The balance of Archimedes was a beam, with bowls suspended from fixed points at each end, and a movable weight adjustable on one arm of the beam, which was graduated from the fulcrum to the point of suspension of one of the bowls. By adjustment on the arm, the weight was made a counterpoise equal to the difference between the weights in the respective bowls.

The balance of Mohammed Bin Zakazîyâ differed from that of Archimedes by the introduction of the indicator-needle attached to the beam, and called by the Arabs the *tonguo*, and by the substitution of a movable suspended scale for the movable weight to balance the difference between scales. Both were described and exhibited by Al-Khâzinî in his work above referred to.

1. The original form of weighing scales was probably a bar suspended by the middle, and with a board or shell suspended from each end, one to contain the weight, and the other the matter to be weighed. Parts of the original picture (Fig. 530)

Fig. 530.



Egyptian Scales.

are defaced by time, as indicated. An ancient Egyptian balance, consisting of a wooden beam and a piece of lead at the end for a weight, was found at Sakkarah.

In early times, before the coinage of money, the precious metals were weighed out, and the duty of weighing was regulated by the municipality, and attended to by public weighers, as we see in the Egyptian monuments and read in classic literature.

Abraham paid for the land he bought in silver, *weighing* it out to Ephron, 400 shekels of silver.

The sons of Jacob also paid for the wheat they bought in Egypt at a given price in metal, weighed out to the officers of Joseph.

For the early uses and gradual improvement in the production of coin, see COINAGE.

The "balance" of the Bible was similar to that of Egypt, the ends of equal length, and the beam suspended by its mid-length. The frequent reference to false and unequal balance shows that the lever-balance on the "steelyard" principle was unknown to them.

The lever of unequal lengths on each side of its point of suspension affords a convenient mode of determining weights of various objects with but a single weight, the object being suspended from the end of the shorter arm, while the bob is shifted along the graduated longer arm until it forms an exact counterpoise for the object weighed. This is called the *steelyard*, probably from its material and former length in England, and is also known as the *Roman Balance* (*Statera*). See STEELYARD.

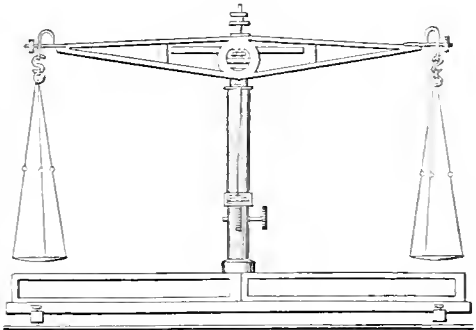
Balances for delicate operations, such as those used in assaying and chemical manipulation, are made with extreme care. The beam should be as light as possible consistent with inflexibility; for not only the inertia, but also the friction, is increased in proportion to the weight, and the sensibility consequently diminished. A cylinder of steel passing at right angles through the center of the beam forms the axis; and its extremities, ground into sharp edges on the lower side, serve as the points of support. The two edges must be accurately in the same straight line, and turn on smooth planes of agate or polished steel, carefully leveled. The pans should likewise be suspended from the extremities of the beam by agate planes resting on knife-edges. A needle or tongue is usually attached to the beam, pointing directly upward or downward, when the beam is horizontal, for the purpose of indicating the deviations of the beam from the horizontal position, on a graduated scale. It is better, however, to bring the arms to terminate in points, and to place a divided scale behind each. In this way the slightest deviation of the beam will be rendered evident, if the zeros of the scales be placed exactly in the same level. The scale is indispensable, because the balance, if very sensitive, would require a long time to come to rest; but it is known to be poised when the excursions of the needle on both sides of the zero of the scale are equal. In order to preserve the knife-edges, the beam, when not in use, is supported on rests. Props should also be placed under the pans when loading or unloading the balance. The whole apparatus must be placed under a glass case, to protect it from the disturbing influences of currents of air.

The sensitiveness of a balance constructed with due care may be carried to almost inconceivable extent.

Analytical balances are usually made to carry 1,000 grains in each pan, and to turn with the $\frac{1}{1000}$ part of a grain.

There are several large balances in use in the English mint, calculated to weigh from 1,000 to 5,000 ounces Troy. Some of them turn with $\frac{1}{10}$ of a grain, when loaded with 1,000 ounces in each scale, or with $\frac{1}{5000000}$ part of the weight.

Fig. 531.



Coin Balance.

To the mode of suspending the beam and the scales more attention has probably been directed than to any other part of the balance.

Of some of the European balances, —

Fox's beam has pivots, the conical ends of which play in hollow agate cones of larger angle.

OERTLING'S beam is coated with platinum or palladium, the knife-edges and planes being of agate, and the instrument proof against acid fumes. The knife-edges are let into dovetailed notches in the beam. The beam is graduated, so that small differences of weight can be determined by placing a small platinum wire weight on one of the divisions of the graduated beam.

STEINHEIL suspends the beam by wires or silk cords. In another of Steinheil's, the beam carries two small steel spheres in the middle, resting on a steel plane, and a sphere at either end, upon which rest the plane or slightly convex spherical surfaces of the plates, from which the pans are suspended.

Among the modes of delicately adjusting the parts to obtain perfect equilibrium may be cited : —

In DOVER'S the final adjustments in the direction of the length of the beam, and in a direction perpendicular to it, are affected by a cut at each end of the beam, making an angle of 45° with the axis of the beam, and capable of being widened by a screw.

In the *American* balance the socket in which one of the extreme knife-edges is fixed moves in a slit in the direction of the length of the beam, and is adjusted by means of two screws.

In OERTLING'S the adjustment of the distance of the extreme knife-edge from the middle knife-edge is effected by a vertical cut in the metal of the beam, capable of being slightly widened or contracted by screws.

Among the modes of checking the oscillation of the pans may be mentioned Dolberg's, which consists of hair-brushes turning on a handle, and ascending till the ends of the brushes touch the under side of the pan. The mode of obtaining quiescence of the pan in the periodical intermittence of the coin-weighing apparatus is by a depressed ivory point above and an agate point beneath.

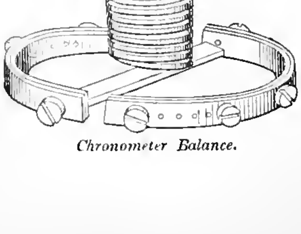
In Fox's balance the beam is brought to zero by the attraction of a magnet.

The sensitiveness of a balance depends (after friction has been reduced to a minimum), first, on the proximity of the center of gravity to the point of suspension on which the beam swings; and the center of gravity must be directly below the point of suspension. Secondly, on the fact that all three knife-edges are in the same plane, to prevent the farther lowering of the center of gravity when the beam is loaded. Thirdly, on the rigidity of the beam, to prevent a similar lowering by springing.

See Faraday's "Chemical Manipulations" for suggestions in construction and management of delicate balances used in quantitative analysis.

See also COIN-WEIGHING MACHINE; COUNTER SCALES; MICROMETER BALANCE; PLATFORM SCALES; SPRING BALANCE; STEELYARD; WEIGHING MACHINE.

Fig. 532.



Chronometer Balance.

2. (*Horology.*) The oscillating or pendulum wheel of a watch, which gives the pulsations. Its axis is the verge.

In the earliest clocks it was in the form of a balance, and not of a wheel. It consisted of two weighted arms, oscillating on a vertical axis. The clock of Henry de Wick, made in 1379 for Charles V., had a balance of this description. The balance, so far as watches are concerned, is a wheel driven in one direction by the mainspring acting through the train of gearing, and returned by the force of the hair-spring. While watches of the various kinds have balances, their escapements generally constitute their distinguishing features by which they are named and known. See ESCAPEMENT.

In regulating a watch, the length of the beat of the balance is increased or shortened to make the watch go slower or faster. This is done by letting out or taking up the hair-spring. See HAIR-SPRING: COMPENSATION BALANCE.

The clock or watch balance consists of —

The *rim*.

Verge; spindle or arbor.

Spring; which gives the recoil movement.

Regulator; determines the length of spring involved in the movement.

Cock; affords a bearing for the upper pivot.

Potance; a step for the lower pivot.

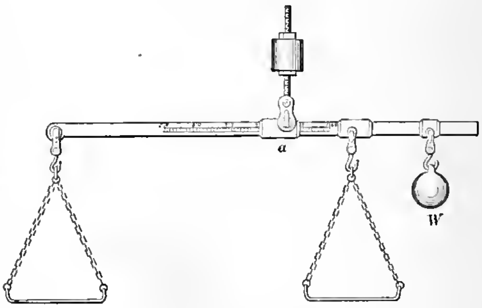
Pallets; the plates on the verge, which engage the *scape-wheel.*

3. (*Electricity.*) A term applied to a device for measuring the resistance of an element of an electric circuit. Also known as a BRIDGE.

Bal'ance, Al-loy'. ROBERT'S Alloy Balance is intended for weighing those metals whose proportions are stated decimally, being constructed on the principle that weights *in equilibrio* are inversely as their distances from their points of support.

The point of suspension, *a*, of the balance is adjusted until the arms are respectively as the two stated proportions, — say 17 tin to 83 copper. The half of the beam is divided into 50 equal parts, numbered from the one end, and, the point of suspension being adjusted proportionally, the weight *w* is brought to a position where it enables the beam of the empty balance to stand *in equilibrio*. A quantity of copper being then placed in the scale suspended from the short arm will be balanced by the proportionate quantity of tin in the other scale. See table in ALLOY, for converting fractions of a pound to decimal proportions.

Fig. 533.



Robert's Alloy Balance.

Bal'ance-bar. (*Hydraulic Engineering.*) A heavy beam bolted to the miter-post of a canal-lock gate, and resting upon the heel-post of the same. It extends over the wharf or pier when the gate is closed, and has two uses, — it forms a lever by which the gate is swung on its pintle, and it partially balances the outer end of the gate.

Bal'ance-bob. A weight on the inner end of a working-beam, to counterbalance the weight of the plunger-piston. The *balance-bob* of the Wicksteed engine of the East London water-works is a receptacle of ballast, weighing about 89,600 pounds.

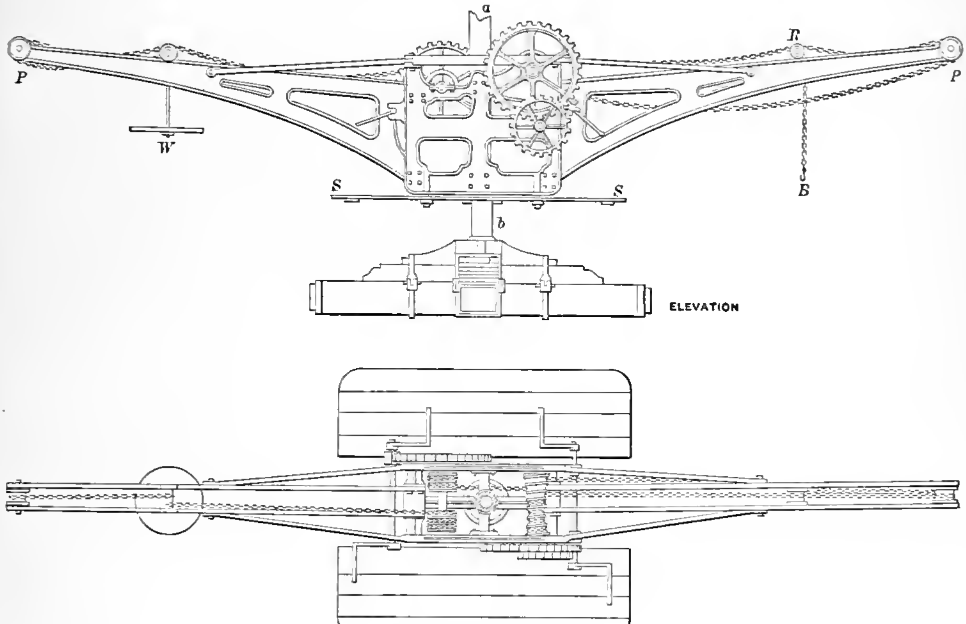
Bal'ance-bridge. A lifting bridge with a counterpoise. A BASCULE BRIDGE, which see.

Bal'ance-crane. A crane having two arms, one of which is provided with arrangements for counterpoising, in whole or part, the weight to be raised by the other.

The following is a description of that employed by Stevenson in the erection of the Skerryvore Lighthouse.

a b is a portion of a cast-iron pipe or pillar erected in the center of the tower, and susceptible of being lengthened as the tower rose, by means of additional pieces of pillar let in by *spigot and faucet joints.* On this pillar a frame of iron was placed, capable of revolving freely round it, and carrying two trussed arms and a double train of barrels and gearing, worked by men standing on the stages *S S*, which revolved round *a b*, along with the framework of the crane from which they hung. On the one arm hung a cylindric weight of cast-iron, *W*, which could be moved along it by means of the gearing, so as to increase or diminish by leverage its effect as a counterpoise; and on the other was a roller *R*. The roller was so connected with the weight on the opposite arm as to move along with it, receding from or approaching to the center pillar of iron in the same manner as the weight did. From the roller hung a sheave, over which a chain moved, with a hook *B* at the end for raising the stones. When a stone was to be raised, the weight and the sheave were drawn out to the end of the arms at *P* of the crane, which projected over the outside of the walls of the tower; and they were held in their places by simply locking the gearing which moved them. The second train of gearing was then brought into play to work the chain which hung over the sheave, and so to raise

Fig. 534.



Balance-Crane used at Skerryvore.

the stone to a hight sufficient to clear the top of the wall. When in that position, the first train of gearing was slowly unlocked, and the slight declivity inwards from the end of the arms formed an *inclined plane*, along which the roller carrying the sheave was allowed slowly to move (one man using a break on the gearing to prevent a rapid run), while the first train of gearing was slowly wound by the others, so as to take up the chain which passed over the sheave, and thus to keep the stone from descending too low in proportion as it approached the center of the tower. When the stone so raised had reached such a position as to hang right over the wall, the crane was made to turn round the centre column in any direction that was necessary, in order to bring it exactly above the place where it was to be *set*; and, by working either train of gearing, it could be moved horizontally or vertically in any way that was required.

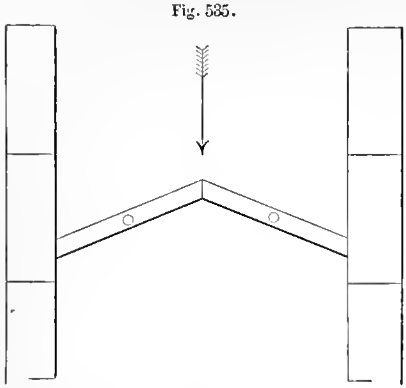
Bal'ance E'lec-trom'e-ter. An instrument having the poised beam of the ordinary balance, and adapted to estimate, by weights suspended from one arm, the mutual attraction of oppositely electrified surfaces.

In HARRIS's electrometer the beam is suspended from an insulated post; one scale, carrying the weight, has its seat upon a post; the other scale is a disk which is suspended above a similar disk electrized by connection with a charged Leyden jar. HENLEY's quadrant electrometer has a pendulous pith-ball whose deflections are measured by a graduated arc.

Bal'ance-frames. (*Shipbuilding.*) Those frames of a ship which are of equal area and equally distant from the ship's center of gravity.

Bal'ance-gate. (*Hydraulic Engineering.*) A form of flood-gate which has a vertical shaft as a center. As the leaves on each side of the pintle are of equal area, a very small power is necessary to open them in whichever direction the water may be pressing. By giving a preponderating area to the inner leaves of the gate, they may be made self-opening or self-closing as the current sets in or out of a channel. In this form they are commonly used as sluice-gates in Holland.

Fig. 535.



Balance-Gates.

Bal'ance, Hy'dro-stat'ic. See SPECIFIC-GRAVITY BALANCE.

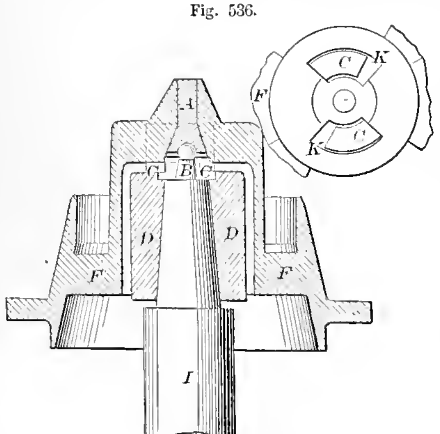
Bal'ance-lev'el. (*Surveying.*) An instrument suspended by a ring. When in equilibrium, two sights, properly fitted to the instrument, show the line of level.

Bal'ance-knife. (*Cutlery.*) A table-knife, of which the blade and handle counterbalance each other, so that the blade may not touch and soil the cloth.

Bal'ance-reef. (*Nautical.*) In a square sail, a diagonal reef-band from the outer head-earing to the tack. In a fore-and-aft sail, it extends from near the outer point of the upper horizontal reef-band to a point higher up at the inner edge of the sail.

Bal'ance-rynd. (*Mill.*) An iron bar stretching across the eye of the runner, and by which it is poised on the top of the spindle. In the illustration, *I* is the *spindle* of the runner; *B* the *cock-head*, on which the *balance-rynd F F* is poised. The latter has a capacity for rocking back and forth on the

Fig. 536.



Balance-Rynd.

spindle to a given extent, as the *runner* finds its adjustment on the *bed-stone*. The driving-block *D D* sits on the square of the spindle, and the driving-lugs *C C* bear in the slots of the balance-rynd, and drive the stone when the spindle *I* is rotated.

Bal'ance-sec'tion. (*Shipbuilding.*) One of a pair of vertical cross-sections, one near each end of the vessel, which are designed after the midship section and leading water-line.

Bal'ance Ther-mom'e-ter. A thermometer poised on an axis, and having ether and mercury in the respective ends. When an unusual heat occurs, the ether is expanded, and drives the mercury farther towards the end, which tips the instrument and sounds an alarm. A form of *fire-alarm.*

Another form of *balance thermometer* is an inverted tube, which acts as a counterpoise to a window, register, or damper. The upper end of the tube has an air-bulb, the lower end of the stem containing mercury, into a cup of which the end is submerged. As the temperature increases, the air expands, displaces the mercury, the tube rises, and the window or damper is moved. The converse operation takes place when the temperature falls. See THERMOMETER.

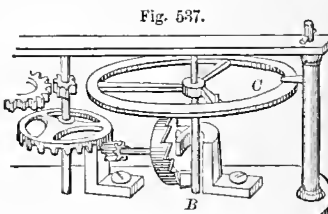
Bal'ance-valve. A valve of any character in which steam is admitted to both sides, so as to render it more readily operated by relieving its pressure upon the seat. The balance *puppet-valve* has two disks of slightly differing diameter, and placed on a single stem; the steam being admitted between the two, or above and below the upper and lower disk respectively. The slight difference in size is in favor of the pressure of the valve on the seat.

The object is to secure a large opening without great resistance.

Bal'ance-vise. (*Watchmaking.*) A small tail-vise, used by watchmakers.

Bal'ance-wheel. In horology this signifies the ratchet-formed scape-wheel in the old *vertical-movement* watch. Its teeth are acted upon by the pallets of the verge *B*, which is the axis or spindle of the balance *C*, and the latter, in its oscillation, makes the time-beat, acting as the pendulum in a clock.

Fig. 537.



Balance-Wheel.

The term *balance-wheel* is sometimes applied to the *balance C*, which acts as the measurer of time, and *balances* or regulates the rate by applying its pulsations to intermit the action of the spring. So the term *balance-wheel* has gradually been conferred upon fly-wheels which confer regularity of motion to the machinery to which they are applied.

The term *balance* is derived from its original form, consisting of weighted arms upon an oscillating axis, and having a semblance to the beam of the balance when it oscillates on its pivot or bearings. This was the form of the balance in Henry de Wick's clock, constructed for Charles V., in 1379.

Bal'ance-wheel En'gine. (*Horology.*) An instrument for forming the ordinary balance-wheel of a watch, which consists of a four-spoked, full-rimmed wheel of steel, and is made of a steel disk from which the segments are punched out, the *crossed wheel* being finished by a file.

Bal'ance-wheel File. (*Horology.*) Or *Swing-wheel File.* A file adapted to cut out the sectors from the circular steel plate, which forms the blank for the balance-wheel.

Bal'co-net. A low, ornamental railing to a door or window, projecting but slightly beyond the sill or threshold.

Bal'co-ny. 1. (*Architecture.*) A projecting stage or platform on the outside of a building, usually supported by consoles or columns, and furnished with a rail or other enclosure.

2. (*Shipwrighting.*) The stern gallery of a ship.

Bal'da-chin. (*Architecture.*) A canopy supported by columns, and raised over altars, tombs, etc.

Bale. A bundle of stray, hay, or other material, put up in compact form for transportation or storage.

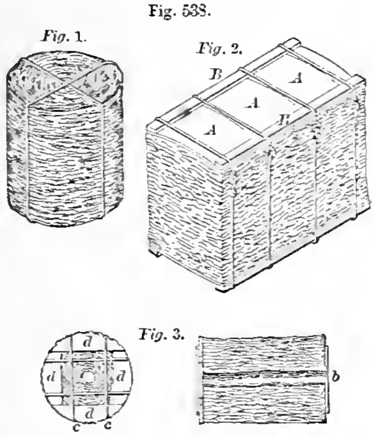
Many ingenious devices for putting up forage rations and cut-stuff for feed have been devised from time to time, especially since the United States military stations have been so widely established.

The bale 1 is made up of a roll or rolls of hay or straw, laid in coils, and fastened by cords or wires crossing it longitudinally at right angles.

In 2, the top and bottom of the bale are covered by transverse strips *A A*, curved so as to shed water, and the edges are protected by longitudinal strips *B B*.

3 shows a cylindrical bale, having a central hollow *b* extending from end to end. The ends are strengthened by segmental strips *d d*, which protect the edges, leaving the body of the bale open to free ventilation. Longitudinal ties *c c* bind the whole together.

Fig. 538.



Bales.

Ba-leen.' The plates of fibrous material with a bristly fringe, which depend from the upper jaw of the *right whale* (*Balæna mysticetus*). There are about 200 of these plates on each side of the mouth in the outer row. These are from 10 to 15 feet in length, and about one foot broad at their base. An inner row of smaller subsidiary plates is arranged obliquely. The material is called *whalebone;* but the word is quite inappropriate, as it is not of the nature of bone.

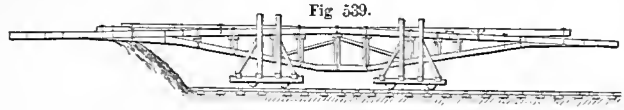
The material is used for the ribs of umbrellas, stiffening for corsets, for chimney and street brooms, elastic brushes, heckles for flax-brakes, and is split into splints for plaiting like straw.

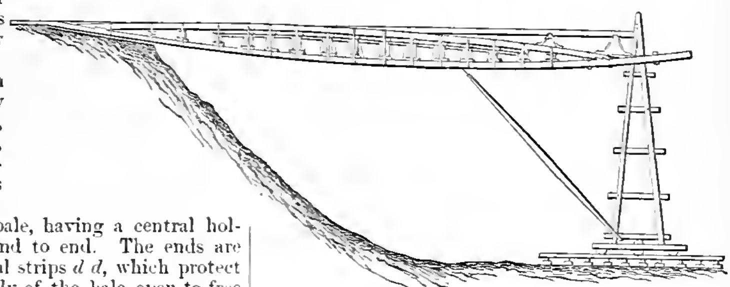
Strips of *baleen* have been aggregated by pressure, moisture, and heat, so as to become agglutinated, and thus form larger articles, such as walking-canes. Kortright's English Patent, 1841.

Artificial baleen is made in Germany, and consists of rattans impregnated with a strong black varnish. It is called *wallosine.*

Ba-leine'. A movable scaffold, employed in France to facilitate the tipping of the wagons in railroad embankments.

Fig 539.





Baleine.

It consists of two trussed beams, which are laid with rails along the top, one end resting on the ground at the commencement of the embankment, or at the battery-head of an embankment in course of formation; the other end of the *baleine* rests on a wheeled carriage, or an auxiliary railway, the rails of which are taken up at one end as the other progresses. When a car is tipped at the battery-head, the contents are discharged between the rails, and it is pushed to the other end of the *baleine.* The same plan is followed with the rest of the loaded cars until the *baleine* is full. The empty cars are then coupled and withdrawn by the locomotive.

Bale-tie. A device for fastening the ends of the hoops by which bales of cotton are held in compact form.

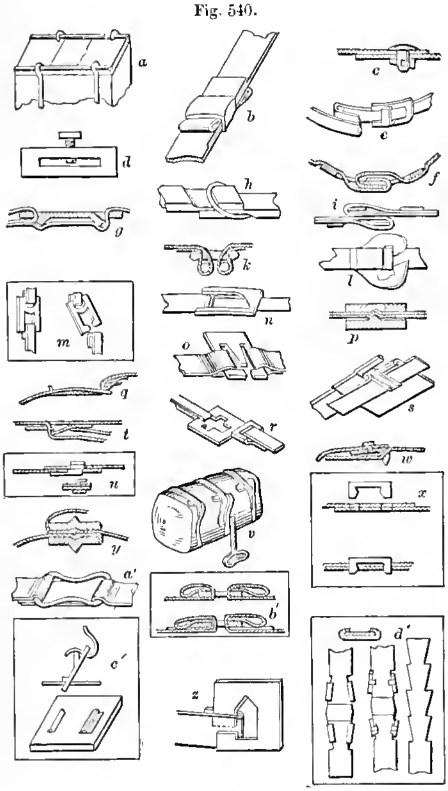
The annexed cut shows 29 of these devices, which are selected from a much larger number, to illustrate, not only the devices themselves, but also the number of modes in which so apparently small a problem may be solved.

The name and date are simply given, as the construction and operation will be generally understood without special explanation.

a.	SABATIER	(English),	1796.
b.	BLAIR	"	1802.
c.	BRECK	"	1807.
d.	SMITH		1849.
e.	MCCOMB,	June 15,	1856.
f.	BROAD,		1850.
g.	SWETT,	Oct. 23,	1866; reissued May 7, '72.
h.	MCCOMB,		1850.
i.	COOK,	March 2,	1858.
k.	BRODIE,	" 22,	1859.
l.	BEARD,	Oct. 16,	1866.

m. Jordan,	Aug.	28, 1870.
n. Morris,	April	6, 1859.
o. Adams,	Feb.	20, 1872.
p. Peyton,	July	18, 1871.
q. Lecky,	Oct.	29, 1867.
r. Sechler,	March	19, 1867.
s. Sheppard,	Aug.	22, 1871.
t. Latting,	Dec.	18, 1866.
u. Onions,	June	5, 1866.
v. Lee,	Oct.	16, 1866.
w. Milligan,	Nov.	6, 1866.
x. Merritt,	April	10, 1866.
y. Quant,	Oct.	28, 1865.
z. McComb,	Jan.	29, 1861.
a'. Seaver,	Oct.	23, 1866.
b'. McComb,	"	23, 1866.
c'. Wailey,	"	9, 1866.
d'. Gridley,	"	23, 1866.

Fig. 540.



Bale-Ties.

In connection with the subject of ties for bales may be mentioned the devices for baling cut hay, and for baling feed and forage rations, to condense their bulk for transportation. The latter are especially intended for military and emigrant purposes.

One plan is briefly as follows: —

The hay is carried by an endless apron to a rotary cutter driven by power, and which, cutting past a fixed blade, chops the hay into pieces of from three fourths of an inch to one and a half inches in length. After this it passes through a winnowing apparatus, which abstracts all dust and dirt therefrom, and then between crushing-rollers, which crush it flat and render it soft and flexible; in this condition it is placed in a strong press and compressed into a bale of great solidity and compactness, which, when properly hooped or banded, is ready for transportation. By these means the size of bale for a given weight of hay is materially reduced, while the thorough removal of dust, etc., and the softening of the material from the crushing to which it has been subjected, increase its value for feeding purposes.

The bales contain about nine cubic feet, and weigh 200 pounds.

In baling forage rations, a feed of corn is placed in a feed of hay, and the whole condensed into the shape of a large brick.

Bal'ing-ma-chine'. (*Hydraulic Engineering.*) An apparatus consisting of a square bucket, sliding on a nearly vertical rabbeted beam, dipping at its lower position into the water in the hold or ditch, and discharging its contents upon deck.

The bucket has a flap-valve at bottom, which opens when it reaches the water. It is hoisted by means of tackle. When the bucket reaches the top, a part of the slide tilts over and tips the bucket, which discharges its contents. See also Bail-scoop.

Bal'ing-press. A press for condensing fibrous articles of considerable bulk into a compact form, for the purpose of shipment.

It essentially consists of a bed, inclosing sides, and a head, platen, or follower, operated by means of screws, toggles, beaters, rope and pulley, or by other mechanical devices, as will hereafter appear.

The varieties may be thus enumerated, and will be considered in their alphabetical position under the following heads: —

1. Screw press.
2. Toggle press.
3. Beater press.
4. Revolving press.
5. Hydraulic press.
6. Portable press.
7. Double-acting press.
8. Windlass press.
9. Rack and pinion press.
10. Repressing press.
11. Rolling-pressure press.

Other minor varieties and sub-varieties might be cited were there any object in multiplying definitions.

Ba-lise'; Ba-lize'. A timber frame raised as a beacon or landmark.

Balk. 1. (*Carpentry.*) *a.* A squared timber, long or short, suitable for a *beam* in a frame, a *tie* in a truss, a *girder* in a floor, a *sill* in a building, or for a *shore* or *chock* when of shorter proportions. Baulk; Bauk; Bawk.

b. A large timber in a frame, trestle, truss, or floor.

c. A whole timber. Technically, over 13 inches square. Half-timber is 6¼ inches square.

2. (*Military Engineering.*) A longitudinal timber of a ponton-bridge.

Ball. 1. (*Games.*) A sphere of ivory, wood, etc., used in billiards, bagatelle, croquet, and other games.

Balls for playing are made of various sizes and materials, according to their intended purpose. That, perhaps, most familiarly known, is ordinarily composed of an interior core of india-rubber, usually, if not always, made up of strips wound into spherical form, around which is wound woolen yarn, the whole being covered with leather. Many are also made wholly of india-rubber, and hollow.

Billiard-balls are made of ivory, that substance combining in the highest degree the required qualities of resiliency and durability. Ten-pin balls are of lignum-vitæ. Boxwood is preferred for croquet-balls. See also Ivory, artificial.

The game of ball is mentioned by Homer (*Odyssey*, viii. 372), and was credited by Plato to the Egyptians, among whom it was known in the twelfth dynasty, say 2000 B. C.

The Athenians erected a statue to Aristonicus on account of his skill in ball-playing.

Foot-ball is very much in vogue among the American Indians, large parties of whom participate in the sport. Its practice among the Indians of the Plains is well described in Catlin's "North American Indians."

Tennis was played in England in the sixteenth century. The tennis-court at St. James's was erected in 1676. This game was for many years a favorite amusement with the nobility of England and France.

The invention of billiards is ascribed to Delvigne, 1571. We find cricket first mentioned in 1719.

Croquet was introduced into England from Germany in 1830; its popularity in America hardly dates back more than a decade.

2. (*Projectiles.*) A missile to be projected from a fire-arm, *e. g.* a bullet or cannon-ball. These are made of lead for small-arms, and of cast-iron for cannon, though in countries where copper was plentiful and iron scarce, as in South America and Mexico, the former metal was employed, even when imported cast-iron cannon were used. The lack of tin, and perhaps want of skill, forbade the people of those countries to cast bronze ordnance, though they could make copper shot.

Weight of Cast-iron Balls.

Diameter in Inches.	Weight in Pounds.	Diameter in Inches.	Weight in Pounds.
1	.1377	6¾	42 34
1¼	.268	7	47 23
1½	.464	7¼	52 46
1¾	.737	7½	58.09
2	1.10	7¾	64 09
2¼	1.56	8	70 60
2½	2.15	8¼	77.31
2¾	2 86	8½	84.56
3	3.71	8¾	92 24
3¼	4.71	9	100 38
3½	5.90	9¼	108 98
3¾	7.26	9½	118 05
4	8.81	9¾	127.62
4¼	10 58	10	137 70
4½	12.54	10¼	148.28
4¾	14.15	10½	159.51
5	17.21	10¾	171.06
5¼	19.92	11	183 27
5½	22 89	11¼	196 05
5¾	26.17	11½	209 42
6	29.74	11¾	223 38
6¼	33 61	12	238.04
6½	37.81		

3. (*Printing.*) A dabber for inking type or calico-printing blocks. Its mission is nearly ended in either capacity. It consists of a piece of buckskin stuffed with wool so as to form a ball, and furnished with a handle. The corresponding device used by the engraver in spreading etching-ground is called a *dabber*.

4. (*Fabrics.*) A round cop of thread or yarn.

5. (*Metal-working.*) A spherical tool for cutting; such as those for excavating bullet-molds, carious teeth, etc.

6. (*Metallurgy.*) A loop (Fr. *loupe*; Ger. *luppe*) or mass of iron gathered into a lump in a puddling-furnace, and in a condition fit for the squeezer or tilt-hammer.

7. (*Machinery.*) *a.* A spherical valve, operated by the passing fluid, and limited as to its extent of motion by a cage, or by the size of the chamber.

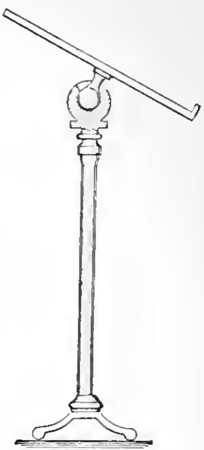
b. One portion of that universal joint which consists of a ball gripped by a box and ring.

8. (*Horological.*) The weight at the bottom of a pendulum, sometimes called the *bob*.

Bal'la-hore. (*Nautical.*) A West India schooner with fore and aft sails only; the foremast rakes forward, the mainmast aft.

Ball-and-sock'et Joint. A joint formed by a ball working in a hollow cup or socket, which allows it free motion in every direction within certain limits. See UNIVERSAL JOINT.

Fig. 541.



Ball-and-Socket Joint.

Bal'last. 1. (*Railway Engineering.*) Gravel, broken stone, or cinders placed beneath and around the sleepers of a railroad track, forming a solid bed which will not retain water. Drainage must be provided below the *ballasting*. In England, where it is also called *metal*, two-feet bed of ballast is deemed sufficient, no water being allowed to stand within a depth of four feet below the rails.

Ballast has four duties to perform: —

a. To distribute the bearing over the surface of the earthwork.

b. To confine the track in place.

c. To permit drainage of the surface.

d. To afford a certain degree of elasticity. A solid rock sub-way is too unyielding, and injures the rolling stock. Burned clay is a fair material. Cinders, shells, and small coal are also used in certain localities.

2. (*Nautical.*) Weight in the bottom of a boat or the hold of a vessel, to keep it upright in the water, and prevent its being upset by the force of the wind or the weight of its *top-hamper*.

On board vessels of war *pig-iron* is generally employed for ballast; that of the British navy consists of iron pigs of about 300 pounds each.

Means have been provided for using water as ballast. Its evident convenience, both as to accessibility and facility of removal, have induced considerable pains to be incurred in devices for containing it.

The employment of water-tight bags has been several times attempted. These, when empty, are stored away in large boxes, and when required are spread out in the hold and filled by a connecting hose. There are evident objections to this mode.

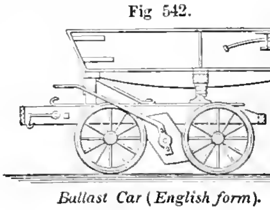
Iron tanks have been built into the ship, occupying positions on the floor, and at the stem and stern next to the *dead-wood*.

Tanks made by two bulkheads across the vessel have also been used. These are made of such a size that they may be used for coals or cargo when the ballast is not required. The reservoir, whatever form it may have, must be quite full, to prevent the swashing of the water, and the bulkhead tank has been found difficult to fill and keep tight.

The plan suggested by Grantham, of Liverpool, — a distinguished authority on the subject, — is specially adapted for ships carrying coal, where little or no back freight is to be had. See Grantham's "Iron Ships," Weale's Series.

Bal'last Car or Wag'on. (*Railway Engineering.*) A dumping-car for transporting ballast for the road-bed.

Fig 542.



Ballast Car (English form).

In the illustration is seen the

English form, having a capacity for dumping to the rear or towards either side. See DUMPING-CAR.

Bal'last-en'gine. 1. (*Hydraulic Engineering.*) A dredging-machine for raising shingle from the bottom of a river for ballasting vessels.

2. (*Civil Engineering.*) A steam-engine employed in excavating and shoveling gravel for ballasting a road-bed.

Bal'last-heav'er. (*Hydraulic Engineering.*) A dredging-machine for raising ballast from a river-bed.

Bal'lasting (*Engineering.*) *a.* The gravel or broken stone, known as *metal*, which forms the road.

b. The material beneath and around the sleepers of the *permanent way* of a railroad. See BALLAST.

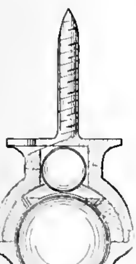
Bal'last-light'er. (*Nautical.*) A barge for conveying ballast to a vessel.

Bal'last-shov'el. (*Nautical.*) A square-bodied and spoon-pointed iron shovel.

Ball-cal'i-ber. A ring-gage for testing the diameter of gun-shot on board ship.

Ball-cart'ridge. For small-arms; powder and ball in an envelope. In contradistinction to *blank*-cartridge. See CARTRIDGE.

Fig. 543.

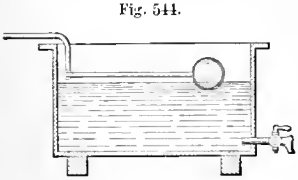


Ball-Caster.

Ball-cast'er. A caster for furniture, etc., having a sphere or ball instead of a common roller at bottom.

Ball-cock. A faucet which is opened or closed by means of a ball floating on the surface of the water in the vessel, allowing the cock to remain open until the water has attained a certain hight, when it is closed by means of a rod connection with the rising ball, falling again as water is withdrawn from the vessel. It constitutes an automatic arrangement for keeping the water at a certain hight. It is useful in cisterns, water-backs, boilers, etc., where the supply is constant, the demand intermittent.

Fig. 544.



Ball-Cock.

Ball-gud'geon. A pivot of a spherical form which permits lateral deflection of the arbor or shaft, while retaining the pivot in its socket.

Ball'ing Fur'nace. (*Metallurgy.*) A furnace in which *piles* or *fagots* of iron are heated so as to form balls for rolling. In the *puddling-furnace*, pig-iron is boiled to drive off certain impurities, and the iron therein is formed into balls by the *rabble* or *paddle* of the puddler, so as to be ready for the shingling-hammer or the squeezer which drives the slag from the bloom. At the same heat the iron may be rolled and become a merchantable article of bar-iron; but with some qualities of iron, and for the production of the finer varieties of bar and sheet iron, the bar from the first rolling is cut up by the shears, and made into piles or fagots, which are reheated to form *balls* for re-rolling.

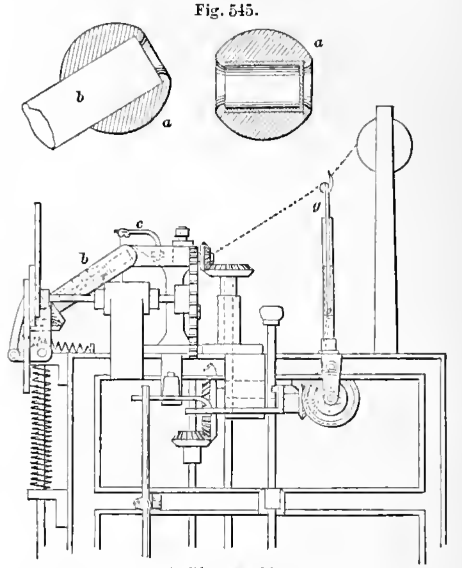
The furnace resembles a puddling-furnace, with the exception that it is not designed for stirring and puddling, but the *piles* or *fagots* are laid upon the floor of the reverberating chamber, and are there heated without running together, each being withdrawn as it attains the required condition. The bottom is made up from time to time with sand. It is not a *mere* reheating, but the action of the fire and the admission of regulated quantities of air remove certain impurities which have resisted the previous operations.

Ball'ing-gun. An instrument for administering medicine rolled into balls to horses. It consists of a partially exhausted tube, on the end of which the ball is held by pressure of air, and from which it is released by a piston when the ball is fairly within the esophagus.

Ball'ing-iron. (*Farriery.*) A hook for clearing a horse's feet from the balls of snow, etc., retained by the shoes.

Ball'ing-ma-chine'. (*Cotton Manufacture.*) A machine on which cotton thread is wound into balls.

Fig. 545.



Balling-Machine.

The ball *a* is made on a rotating spindle *b*, or on a paper cap or cover placed thereon, around which a steel rod *c* spins rapidly, carrying the thread and building it up on the spindle. This interior core (cap) forms a support for the ball, and receives on its closed end the ticket, number, and maker's name.

The size of the ball is regulated by the eye; the number to the pound varies from 16 to 600.

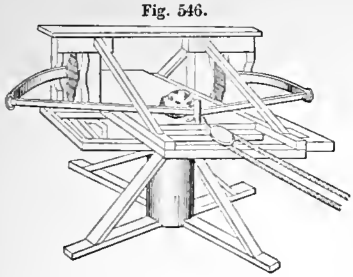
The spindles have independent stop-motions, *g*, so that when a thread breaks any one or more may be stopped. The thread comes off a bobbin, and passes through the hollow spindle of the flyer *c*, whose axis of rotation is oblique with that of the spindle *b*, so that the thread is laid on spirally, the spindle continually rotating so that the thread has an advancing or receding coil, according to the direction of motion of the spindle. The gearing by which the parts are driven is sufficiently shown in the cut, and needs no special description. The figure shows one set of parts, but the machine has a long parallel series of ball-winders in a row on a single frame. The upper figures show the ball attached to and detached from its spindle, respectively.

It was invented by M. I. Brunel. When he visited the mills of Strutt, in Derbyshire, about 1805, he said he "observed they had adopted my [his] contrivance for winding cotton into balls."

Ball'ing-tool. (*Metallurgy.*) A tool for aggregating the iron in a puddling-furnace, to fit it for conveyance to the tilt or squeezer. A *rabble* (Fr. *râble*).

Bal-lis'ta. (*Weapon.*) A machine used anciently for throwing darts or stones.

Fig. 546.

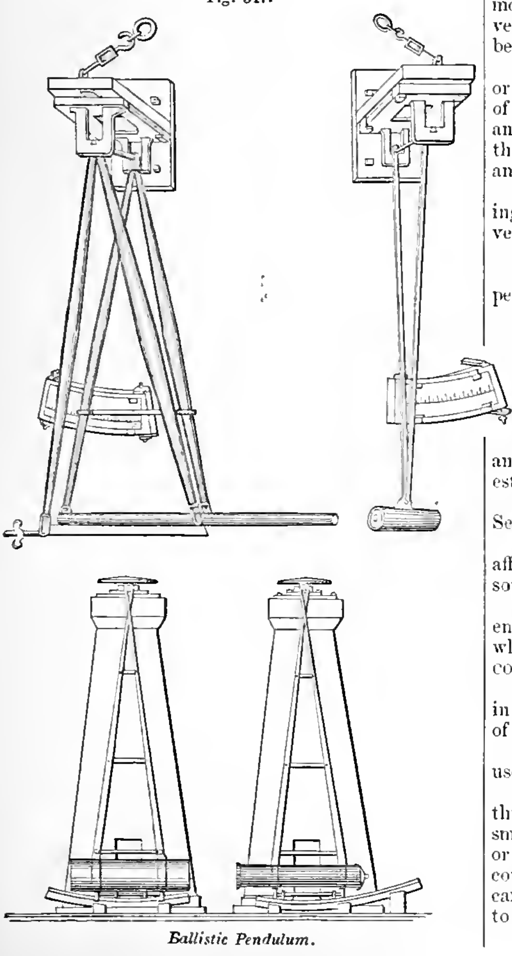


Ballista.

The name is applied to two different machines. One resembles the catapult in the mode of obtaining the power, and the other is a cross-bow on a large scale, with a tackle to draw the bowstring.

a. The more ancient ballista had a vibrating arm, which was drawn back against the tension of cords made of human hair, horse-hair, or catgut. When drawn back to its full scope, it was suddenly released, and its head came with a violent blow against the ends of the darts arranged on a table above and pointed towards the enemy.

Fig. 547.



Ballistic Pendulum.

b. The other ballista was a cross-bow, arranged upon a standing frame (Fig. 546). The string was retracted by a tackle, and was cast loose by some device, projecting a dart or a stone, as the case might be. The dart or stone lay upon a table, and was adjusted against the string before casting off.

Bal-lis'tic Pen'du-lum. This instrument is designed to determine the velocity of projectiles of cannon and small-arms. It was invented by Robbins about 1760, and described by him in his tract on Gunnery. It has been improved by Hutton and Gregory, in England; Piobert and Morin, in France; and Mordecai, in the United States.

The original instrument consisted of an iron bar suspended by a transverse axis, and having a block of wood strengthened with iron plates to receive the impact of the ball. On being struck, the block swung like a pendulum, and pulled a ribbon through an orifice in the fixed framework. The length of the ribbon withdrawn is considered equal to the chord of the arc of vibration.

The use of the pendulum depends upon the dynamical fact that if a body of small mass impinge with great velocity upon a much larger body at rest, and the two bodies after impact move on together with a velocity which can be easily measured, the masses of the two bodies being given the whole momentum after impact is known; and as this is the momentum of the smaller body before impact, the velocity with which it struck the larger body can be determined.

As now used, the block consists of a cast-iron case or mortar, partially filled with bags of sand or a block of lead. It is suspended by wrought-iron bars from an axis working on knife-edges in V-grooves, and the arc of vibration is measured on a copper arc by an index carrying a vernier.

The arc of vibration being ascertained, the following points must be known, in order to calculate the velocity of the ball on striking: —

1. The respective weights of the ball and pendulum.
2. The distance of the centers of oscillation or percussion from the axis of suspension.
3. The distance of the center of gravity from the axis of suspension.
4. The angular velocity of the pendulum after impact.

The upper figure represents the pendulum for small-arms; the lower one for ordnance.

The gun itself has been swung on a pendulum, and its arc of recoil measured to furnish datum for estimating the force of the discharge.

It is also used to determine the quality of powder. See also EPROUVETTE.

The *Chronoscope* and *Electro-Ballistic* apparatus afford more perfect means of determining the point sought. See CHRONOSCOPE: ELECTRO BALLISTA.

Ball-le'ver. A lever having a ball affixed at one end as a weight, which closes the plug of a cistern when the water has risen sufficiently. See BALL-COCK.

Bal'lon. 1. (*Chemical.*) A large glass receiver in the form of a hollow globe, appertaining to a set of chemical apparatus.

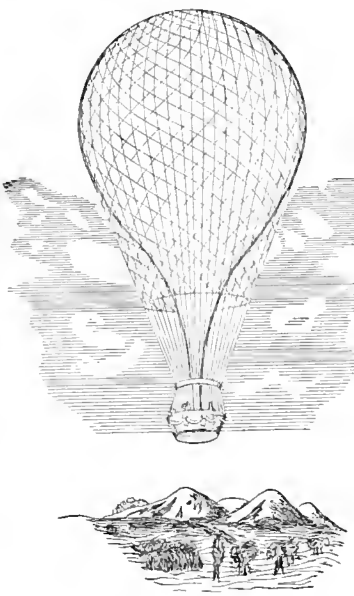
2. (*Nautical.*) A long, brigantine-rigged vessel, used in Siam, and made out of a single trunk.

Bal-loon'. 1. A bag or envelope of silk or other thin textile fabric, around which is a netting of small rope or cord, from which is suspended a car or basket. The balloon is provided with a valve, controlled by a rope within reach of a person in the car, to allow the gas by which the balloon is inflated to escape when it is desired to descend.

Galien, of Avignon, wrote on aërostation in 1575;

but the discovery of hydrogen made by Cavendish, in England, seemed to offer a feasible mode of accomplishing the object, and its use was suggested for that purpose by Dr. Black, in 1767, who ascertained that a light envelope filled with this gas would ascend.

Fig. 548.



Balloon.

The first machine by which an ascent was made into the upper regions of the atmosphere was invented and constructed by the brothers Stephen and Joseph Montgolfier, paper-manufacturers at Annotay, near Lyons, France. After experimenting unsuccessfully with hydrogen-gas, they tried heating the air contained in the balloon by means of a fire in its open mouth, and in June, 1783, a captive balloon was by this means caused to ascend over 2,000 yards. November 21, 1783, Pilatre de Rozier and the Marquis d'Arlandes ascended in a balloon of this kind, reaching a hight of 3,000 feet, and landing nearly six miles from where they arose. December 1 of the same year, MM. Charles and Robert ascended in a balloon inflated with hydrogen-gas, alighting in an hour and three quarters at a spot about 25 miles from Paris, whence they had set out, and attaining an elevation of about 9,700 feet. After this, balloon ascensions, both in France and England, became comparatively frequent. The English Channel was crossed by a balloon; and in making a similar attempt, Pilatre de Rozier and a companion named Romain were killed. They had employed, in conjunction with a hydrogen-balloon, a montgolfiere or fire-balloon below it, and on reaching a considerable hight, the expansion of the gas caused it to flow downward directly upon the fire, inflaming the whole apparatus, which was speedily consumed, precipitating the aëronauts to the earth.

Balloons were introduced into the French armies at an early period during the wars of the Revolution, and were used at the battles of Liege, Fleurus, 1794, and at the sieges of Maintz (Mayence) and Ehrenbreitstein, where they were found particularly useful, as only by such means could operations in the elevated citadel be observed.

"The French armies are attended with a new species of reconnoitering engineers, whose duty it is to do everything relative to the preparation and use of balloons. The person who mounts in the balloon is furnished with paper and pencils of different colors. The marks are made according to a system agreed on beforehand, and the paper, after being marked, is attached to a small rod like an arrow, one end of which is loaded and pointed, so that it strikes in the ground and stands upright." — *Annual Register*, 1794.

Balloons were also employed by the French in the Italian campaign of 1859, at Solferino; and subsequently, during our own civil war, a small corps of balloonists was attached to the Army of the Potomac.

The celebrated French chemist, Gay Lussac, in 1804 reached the hight of 23,040 feet, and carried up with him the necessary means for making scientific observations on the character and properties of the atmosphere at that great hight. This was for many years considered the most remarkable balloon ascent ever made, both in regard to the hight attained and the observations made. The great tenuity of the atmosphere in those elevated regions is said to have affected M. Lussac to such a degree that his system never fully recovered from it. An English aëronaut named Glaisher, it is said, has recently succeeded in reaching the hight of seven miles. He was rendered seriously ill, and was supposed to have burst some blood-vessels.

Charles Green introduced the practice of inflating balloons with ordinary illuminating-gas, making his first ascension with this medium on the day of the coronation of George IV., 1820. Illuminating-gas, besides being much cheaper than hydrogen, has the advantage of being more easily retained within the envelope on account of its greater density.

In 1836, Messrs. Holland, Mason, and Green ascended from London in a balloon of 85,000 feet capacity, taking with them a ton of ballast, a fortnight's provisions, extra clothing, etc. They landed next day in the duchy of Nassau, having made a voyage of about 500 miles.

In June, 1859, Mr. Wise, the well-known American balloonist, ascended from St. Louis and landed in Jefferson County, N. Y., having traveled about 1,150 miles.

Gifford's captive balloon, noted as one of the features of the Paris Exposition of 1867, was 93 feet in diameter, having a capacity of 421,161 cubic feet; weighed 6,000 pounds, the netting and guy-ropes weighing 4,000 pounds additional. It was inflated with pure hydrogen-gas, and the car accommodated twenty-five persons. The rope by which it was held tapered gradually towards its lower end, so that in case of parting it would break near the ground, and not endanger bystanders. It was wound round a drum turned by a steam-engine. The cost of the balloon with its appurtenances, including machinery, was over $45,000.

M. Dupuy de Lorne attempted a few years ago the construction of a navigable balloon of considerable dimensions. In order to maintain its permanence of form, a large balloon was provided with two interior suspended tubes, whose open lower ends communicated with the air; a small interior balloon with valves was placed inside of the larger one, and by its greater or less inflation compressed the tubes more or less, causing the contained gas to rise or fall, so as to cause a uniform tension of the surrounding gas contained in the larger balloon. The longer diameter of this latter was parallel to its axis of motion, and the apparatus was to be propelled by a screw attached to the car and operated by hand-power. The rudder was a triangular sail attached at its lower edge to a pivoted horizontal yard beneath the car, near its rear, and operated by a rope at each end, extending to the steersman's seat.

The British military authorities assume that a hight of 100 fathoms at a distance of 600 fathoms from an enemy affords an ample field of view. Cameras arranged so as to include the whole horizon, enable the country to be photographed, and telegraph-wires, which can be paid out as fast as the balloon sails, afford communication with the earth or with another balloon.

Experiments made at Tours show that at a hight of 1,000 to 1,200 yards the silk envelope of a balloon could be penetrated by bullets, but that the escape of gas was so slow that with a favorable wind the balloon might reach several miles before falling. At 2,700 yards the best shots failed to penetrate the silk; and this elevation is therefore considered the maximum necessary to insure safety.

The late Prussian and French war, and especially the siege of Paris, gave rise to the most business-like and systematic use of balloons on record. The manufacture is thus described by a newspaper correspondent: —

"The type of the balloons constructed by M. Godard for the Postal Administration is entirely spherical. The proportions are as follows: Diameter, 16 yards; superficies, about 836 square yards; volume, 6,316 cubic yards. The stuff employed is a strong glazed cambric, oiled and varnished. With machinery, forty thicknesses of this cambric are cut out at one time. After this operation these strips are sewed together with a double waxed white thread, and the balloon is repeatedly rubbed with oil, in order to secure its impermeability. A valve in strong wood is set into the upper pole of the balloon; this valve is closed by india-rubber springs. A long cord is attached to this valve, and traverses the lower pole, enabling the aëronaut to regulate the descent of the balloon. A network of tarred twine envelopes the balloon. To the extremity of this net a wooden hoop is adjusted, to sustain the wicker-work basket, which measures about 3 feet in width and 4½ in length. Benches are provided for six persons. Around the basket the sand-bags and dispatch-bags, with three hundred yards of rope, are ranged. This latter provision is intended for throwing out to drag on the ground and diminishing the speed on descending.

"The weight, when filled with ordinary burning-gas is about a ton, comprising six hundred pounds of sand-bags, three persons weighing about 150 pounds each, and 1,000 pounds of dispatches. It requires ten days for the manufacture of each. The cost of each is $1,200."

Carrier-pigeons, also, were much used by the Parisians during the Prussian investment of that city. The flying messengers who have their homes in Paris afforded the means of communicating with the beleaguered city. The use of carrier-pigeons is very ancient. On a temple-wall in Egypt there is a sculpture of the time of Rameses II. (1297 B. C.), representing that monarch proceeding in regal state to assume the crown of Upper and Lower Egypt; and in the procession a priest is seen releasing from a basket four carrier-pigeons, to announce the tidings to distant points.

Ovid relates that Taurosthenes announced to his father in Ægeria, by a pigeon stained purple, that he had obtained the prize at the Olympic games. Brutus used pigeons for communicating with the inhabitants of Modena, during its siege by Marc Antony. When Ptolemais in Syria was invested by the French and Venetians, and was about to surrender, a carrier-pigeon, bearing a message from the Sultan, was captured; the missive containing promises of assistance was removed, and one substituted in which the Sultan expressed no hope of being able to assist them. The surrender was immediate. Pigeons were of great use to the Dutch during the siege of Leyden, so bravely resisted by the Prince of Orange.

The *air-car* is a proposed form of balloon, inflated with gas to secure lightness, and traveling upon wires stretched from pillars upon a definite route. Two pairs of wires are needed, — one pair for each side of the car, — and the upper and under wires of the respective pair run in the grooved peripheries of the car-wheels, which are rotated by a steam-engine on board. The car is cigar-shaped, and has sails to be used with favoring winds. The device for passing the posts is ingenious, but does not differ substantially from the mode of hanging the tracks of caster-wheels for sliding barn-doors.

Signals have been made, and notices, etc., have been distributed, by means of balloons. One was invented by Mr. Shepherd, and used in the Arctic regions in the search for Sir John Franklin. The arrangement consisted of a number of printed packets of oiled silk or paper, upon which directions were printed, stating the latitude and longitude of the exploring ships, where they were going to, and the points at which provisions had been left. These were attached at proper intervals to a long slow-match made of rope dipped in niter; and as the balloon traveled over the country, the match burned gradually away, releasing the packets consecutively, and distributing them over a wide extent of country.

Other devices were also adopted for the same purpose, and are described under SIGNALS.

2. (*Architecture.*) *a.* A mold at the base of a column.

b. A round globe at the top of a pillar.

3. (*Glass.*) A glass receiver of a spherical form.

4. (*Fabric.*) A cylindrical reel on which sized woolen yarn for warp is wound, in order to be dried by rapid revolution in a steam-heated chamber. The yarns are guided by passing between the teeth of a *separator* or *ravel*, which is a toothed instrument like a rake, between whose teeth the yarns pass. This acts as a guide in distributing the yarns over the length of the reel.

The yarns are wound from the balloon on to the *beam* of the loom.

Bal-loon'-jib. (*Nautical.*) A triangular sail, used in a cutter, and hauled up to the topmast-head. Sometimes called a *jib-topsail.*

Bal-loon'-net. (*Fabric.*) A variety of woven lace, in which the weft threads are twisted in a peculiar manner around the warps.

Bal'lot-box. A box in which balls or beans indicating a negative or affirmative, or slips containing the names of candidates for office, are deposited.

Ballot-boxes of the ordinary construction afford no security from fraud, except the honesty and attention to duty of the receivers of ballots.

To guard against the improper placing of tickets in the boxes, they have been made of glass, so that the interior might be open to the inspection of the bystanders, and any surreptitious introduction of tickets therein at once discovered.

The ballot was used in ancient times. It has been suggested that of this character was the *Urim* and *Thummim* spoken of in Exodus xxviii. 30: —

"And thou [Moses] shalt put in the breastplate of judgment the Urim and the Thummim, and they shall be upon Aaron's heart when he goeth in before the Lord: and Aaron shall bear the judgment of the children of Israel upon his heart before the Lord continually."

The conjecture that white and black stones were contained in the pocket behind the breastplate, and, being taken out by the high-priest in consultation, gave affirmative and negative answers respectively, is not supported by the weight of authority. It is rather supposed that images representing respectively *Ur*, light, and *Thom*, perfection, were placed in the breastplate, and indicated by a certain luminosity, or by a failure to respond, an affirmative or a negative answer to the question propounded. Such images, emblematical of truth, were used in ancient Egypt, Greece, Rome, and also in China, as well as among the Hebrews. The image was suspended by a cord, so as to lie over the heart of the judge and the high-priest. Aaron became, in a certain sense, a judge in the matters of conscience or religious polity which were submitted to him. See Adam Clark's commentary on Exodus xxviii. 30.

Ovid, in his "Metamorphoses," lib. xv. verse 41, as rendered by Dryden, says: —

> "A custom was of old, and still remains,
> Which life or death by suffrages ordains:
> *White* stones and *black* within an urn are cast;
> The first *absolve*, but *fate* is in the last."

In the promise to the Church of Philadelphia, also: —

"To him that overcometh will I give . . . . a *white* stone, and in the stone a new name written, which no man knoweth save he that receiveth it." — *Rev.* ii. 17.

White was the emblem of purity, pardon, acceptance, choice, triumph, according to the occasion. By white stones judges indicated their verdict, the people voted their suffrages; and a white stone was to the conqueror in the public games the token of his triumph. Such a *white* stone was inscribed with the name of the conqueror, and entitled him to be maintained for life at the public expense. The Athenian magistrates were chosen by lot. Black and white beans were placed with the names in the urns, and the names drawn out with a white bean were elected.

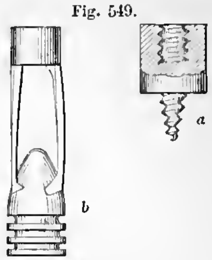
The *tesseræ hospitales* seem to have been particularly referred to in the verse in Revelation. These were a sort of tally: two pieces of stone, bone, wood, or ivory were engraved with some common device, and a piece was kept by each of the two parties contracting a league of mutual friendship and assistance. Such were handed down in the respective families, and guaranteed to the holders all the accommodations and offices of friendship when visiting at the house of the holder of the other portion. Plautus refers to the custom. See Adam Clark in his comments on this passage, and the authors referred to by him.

Secret voting was practiced by the ancient Greeks and modern Venetians, from the latter of whom we derive the term "ballot." A tract, "The Benefit of the Ballot," was published by Marvell in 1693.

Ball-peen Ham'mer. A metal-worker's hammer with a spherical peen.

Ball-screw. An implement for extracting bullets from the barrel of a gun in cases where it would be dangerous or impossible to expel them by firing. It is screwed on to the end of the ramrod, which, being turned, causes the screw-threaded pointed end of the ball-screw to enter the bullet, which is then withdrawn by pulling the ramrod. The common form is shown at *a*, Fig. 549.

Fig. 549.

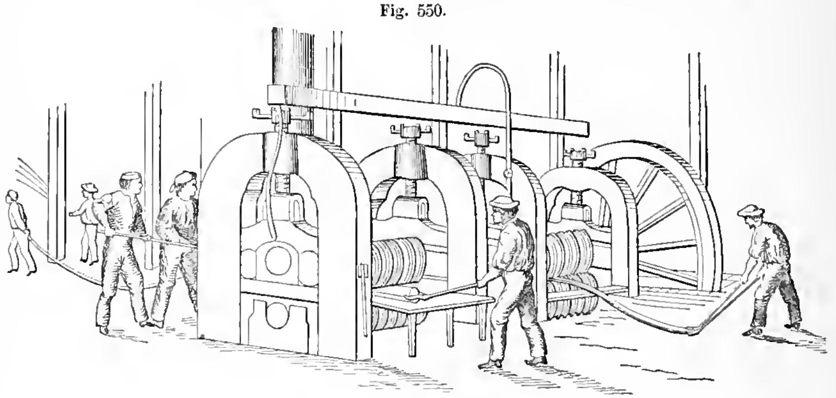


Ball-Screws.

WITZLEBEN'S ball-screw, *b*, has two jaws with sharp-edged interior shoulders, constituting a portion of a concave screw-thread, which enters the bullet to prevent it from slipping from the grasp of the jaws.

Ball-train. (*Metal-working.*) A set of rolls for rolling puddler's *balls* into bars. The word *train* signifies that more than one pair is used, the first being *crushing* rolls and the second *finishing*. The result of the action of the two is *bar*-iron. See ROLLING-MILL.

Fig. 550.

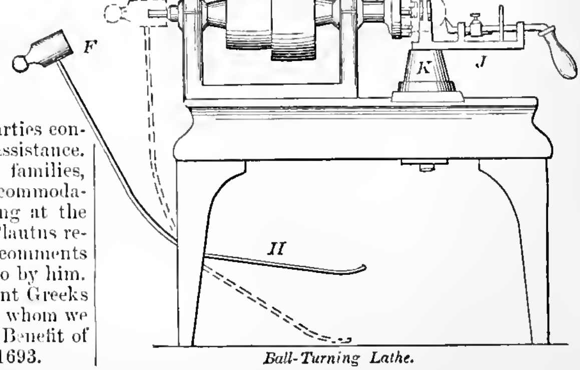


Ball-Train.

Ball-trol'ly. A small iron truck, used in conveying the balls of puddled iron from the puddling-furnace to the tilt-hammer or squeezer.

Ball-turn'ing Lathe. A wood-turner's lathe

Fig. 551.



Ball-Turning Lathe.

for spherical objects, which are held in a chuck on the live-spindle, while the tool has an adjustment in a horizontal arc whose center is coincident with that of the ball.

The block from which the ball is turned is supported at one end only. The chucks are perforated, and the tool is mounted on a swing-rest having a vertical, lateral, and a longitudinal adjustment in its socket, and also a horizontal swinging movement across the axis of the mandrel. *K* is the rest on which the tool-holder *J* swings. The duty of the hammer *H F* is to knock the finished balls out of the chuck.

Ball-valve. A valve of spherical shape, occupying a hollow segmental seat; raised by the passage of the fluid, and descending by gravity. See BACK-PRESSURE VALVE.

Ball-vein. (*Mining.*) A species of iron-ore, found in loose masses of a circular form, containing shining particles.

Bal-mor'al. 1. (*Fabric.*) A striped woolen stuff, deriving its name from Balmoral Castle in Scotland.

2. A sort of ladies' boot, lacing in front.

Bal'ne-um. A vessel filled with some heated substance, as sand or water, in which a thing is placed for treatment that requires a more gentle heat than the naked fire.

Bal'sa. (*Nautical.*) A raft used on the coast of South America, consisting of two inflated seal-skins, which are fastened together at one end to form the prow, and separated abaft by means of a plank. Flexible tubes for inflation are within reach of the navigator, who replenishes the bags as they require. The raft is floored with sticks and matting, and propelled by a double-bladed paddle. It is landed on the shore by the descending breaker, and immediately secured, to prevent its being drawn back by the retreating wave. It carries three passengers besides the navigator.

The CATAMARAN (which see) is often called by this name.

Bal'us-ter. (*Joinery.*) A small pillar supporting a hand-rail, coping, balcony, or terrace. A row of such makes a *balustrade.* They are usually cast hollow, or, when solid, are turned out of stone or wood. The balusters, hand-rails, and base are sometimes made of swaged sheet-metal.

Bal-us-trade'. A hand-rail with its supporting balusters, such as that of a terrace, parapet, balcony, staircase, altar, chancel, or inclosure.

Bal'us-tre. (*Fabric.*) A superior variety of gold cloth, manufactured at Vienna.

Bal-za-rine'. (*Fabric.*) A light mixed material of worsted and cotton for ladies' dresses.

Band. 1. (*Vehicle.*) A circular collar, hoop, or strap, such as that on a nave; a hub-band; an axle-band.

2. (*Architecture.*) *a.* A narrow, flat projecting surface. When narrow, it is a *fillet;* wider, it is a *facia.*

b. The leaden *came* which holds the lozenge-shaped panes in the old-fashioned casement windows.

3. (*Fire-Arms.*) One of the metallic sleeves which bind the barrel to the stock of a musket, etc.

4. (*Bookbinding.*) *a.* One of the cords at the back of a book to which the thread is attached in sewing. Though now a cord, it was formerly a flat band, and hence the name. It usually, in the better forms of binding, makes a raised projection on the back, and in large blank-books is formed by glueing strips of mill-board or leather across the back. In a fine breviary of the fourteenth century, in J. S. Grinnell's collection, it is a thick, rounded, white leather cord secured to beechwood side-boards.

b. The *head-band* serves as a finish to the top and bottom of the sheets, and helps to keep the upper and lower parts of the back in shape when the book is closed.

5. (*Husbandry.*) A bundle of eight or ten stalks of wheat, or other small grain, used to bind a *gavel* of the grain into a sheaf.

Corn-shocks are bound with *stalks*, or with *string, linn-bark* (linden or bass), or *rye-straw.*

String or wire is the usual band on the automatic binding apparatus of *reaping and binding* machines, but a bunch of straw out of the sheaf is used in some machines.

6. (*Machinery.*) A flexible connection between pulleys, generally endless, but sometimes attached by its respective ends to reciprocating sectors, or a sector and slide.

Bands may be classed as *belts, cords,* or *chains.*

A *belt* is generally flat and thin, and requires a nearly cylindrical pulley.

A *cord* is usually circular in section, and made of catgut, raw-hide, twisted fibers, or wire. It requires a grooved pulley.

A *chain* consists of links or jointed bars, and requires a grooved, notched, or toothed drum.

7. A cincture, strap, or cord, with a means of fastening the ends together, and used to confine the materials of a bale, truss, or bundle. See BALE-TIE.

Band'age. (*Surgical.*) A strip or piece of fabric, cotton, linen, or woolen, or an elastic, knitted, or shirred fabric for wrapping any part of the body. They are applied to dress fractured or lacerated parts, for the compression of bloodvessels and the retention in their natural situations of protruding or displaced parts.

They are *simple* or *compound.*

They are named from their purposes, as —

Uniting, dividing, expelling, retaining, compressing, suspensory, varicose-vein, fracture, catamenial.

They are named from their forms, as —

The *axia*, like an axe.

The *spica*, like an ear of wheat.

The *capistrum*, a split cloth bandage to support the lower jaw.

The *chiaster*, a cross-shaped bandage for stopping hemorrhages from the temporal artery.

The 4-*tailed* bandage, made from a single split cloth, and also known as Galen's.

The *figure* 8, the *T*, the *letter D*, the *stellated*, or star-shaped, the *circular*, the *spiral*, the *reversed*, the 18-*tailed*, etc.

They are also named from the materials with which they are treated, as starch, dextrine, plaster of paris, etc.

Ban-dan'na. (*Fabric.*) An India silk, printed in one color with white spots or ornaments made by the *resist* or the *discharging* process. *Bandannois.*

In the *resist* process, the spots are printed with a composition to *resist* the dye by which the ground-color is given. Subsequent washing then removes the dye from the spots, the ground-color remaining intact.

In the *discharging* process, the whole handkerchief is dyed of one color, and is then printed in spots with a composition which discharges the dye at those points, so that, in washing, the spots come up white.

One mode of making the white spots in bandanna goods is by causing a solution of chlorine to percolate down through the red cloth in points circumscribed and defined by the pressure of leaden pattern-plates in a hydraulic press, thereby discharging the color in certain places.

Band-coup'ling. A device for uniting the two ends of a band. This may be a pair of ferrules, with a ball and socket respectively, a hook and eye, strap hinges with a pintle, etc. See BELT-COUPLING.

Band-cut'ting Ma-chine'. (*Agriculture.*) An attachment to a thrashing-machine to cut the bands of the sheaves as they are thrown upon the feed-board. The band being cut, the sheaf is spread out and then pushed head foremost into the *throat*, whence it passes between the *cylinder* and the concave, each of which is toothed.

In England, they prefer to save the straw in a less mangled condition, and feed in sideways; the beaters being bars, not teeth.

Band-driv'er. A tool used in correcting irregularities in the bands of machinery.

Band'ed Col'umn. (*Architecture.*) One having cinctures at intervals.

Ban'de-lore. A toy illustrating the effect of gravity in producing a rotary motion. It consists of two disks, with a deep groove between them, on which is a winding cord. The latter being coiled in the groove, the bandelore is dropped, unwinding the cord; at the end of its stroke, the rotary motion being continued, it rewinds on the cord in the opposite direction, and climbs to nearly its original hight. By a little humoring and motion of the hand, it may be made to rewind the whole length of cord.

Band'ing-plane. (*Wood-working.*) The *banding-plane* is allied to the gages, and is intended for cutting out grooves and inlaying strings and bands in straight and circular works, as in the rounded corners of piano-fortes and similar objects. It bears a general resemblance to the plow, but also has the double-pointed scorer of the grooving-plane. The central plate of the plow is retained, so as to furnish a guide for the central positions of the router and cutter, which are inserted so as to meet at an angle of about 80° between two short portions of the central plate. The whole of the parts entering the groove are compressed within the space of one inch, to pass through curvatures of small radius. A flexible steel fence is attached to the plow by two stays at its ends, while to the central part is attached a screw adjustment to confer upon the fence any required curvature, convex or concave.

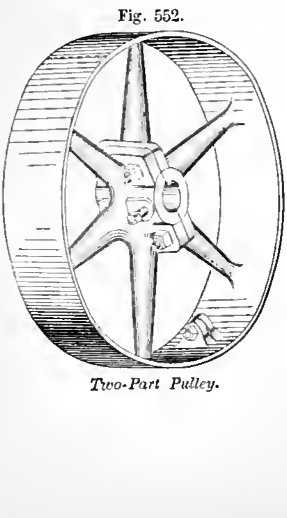
Band'ing-ring. (*Hat-making.*) *Runner-down.* A ring passed over the body of a hat while on the block, so that its edge shall impinge upon the *break* of the band, and form the brim at right angles to the crown in the process of *blocking*.

Band'let. (*Architecture.*) A small fillet or molding.

Ban'dore. (*Music.*) An ancient stringed instrument resembling a lute; referred to in Pepys's "Diary," 1662, — "and music with a bandore for the base."

Band-pul'ley. (*Machinery.*) A flat-faced wheel fixed on a shaft and driven by a band. It is connected either immediately or mediately through other pulleys, with any power which drives machinery.

Fig. 552.



Two-Part Pulley.

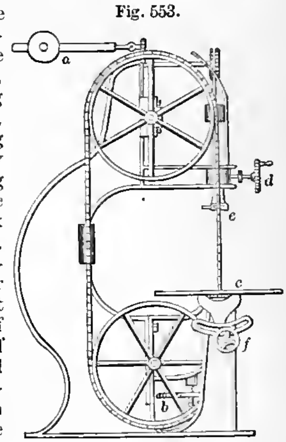
The illustration shows a two-part pulley, having flanges, connected by bolts and nuts, on the hub and rim. A *drum.*

Band'rol. 1. (*Architecture.*) A form of spiral molding in Gothic architecture. *Bandrole.*

2. (*Nautical.*) A little streamer from a mast-head.

Band-saw. The band-saw consists of an endless steel belt running over wheels and revolved continuously. It is pliable, so as to conform to the faces of the wheels, and is serrated on one edge. The ends are joined by solder and by neat clamps. Arrangements are made for straining the saw by regulating the relative distance of the wheels; this adjustment also permits the machine to take in saws of different lengths. One advantage of the band-saw over the reciprocating saw is, that there is no lost time in its operation, and no effort required to keep the work to the table, as the action of the saw tends to this result. There is no need of a pump or blower to clear away the sawdust, as it is carried continually downward.

Fig. 553.

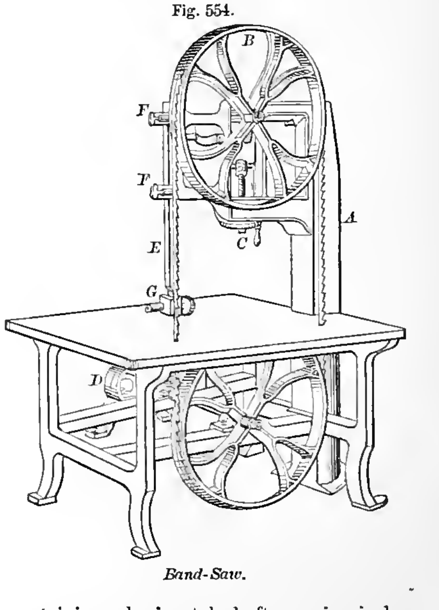


Band-Saw.

In the machine shown there are several adjustments: one by weighted arm *a*, for raising the boxing of the upper wheel, and thus straining the saw; another by wheel *b*, for raising or lowering the table *c*, on which the work is placed; a wheel *d*, by which the saw-guide *e* is raised or lowered, to bring it into the vicinity of the upper surface of the work; a wheel *f*, by which the table is inclined when the work is to be sawed to a level.

In the band-saw represented by Fig. 554, the standard *A* supports a frame, on which is an upright sliding-block and

Fig. 554.



Band-Saw.

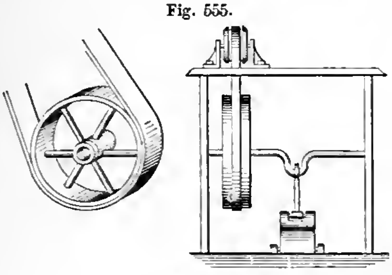
arm sustaining a horizontal shaft running in boxes. On this shaft is hung the upper wheel *B*, which, by means of the screw and hand-wheel *C*, can be elevated or lowered as the length of the saw demands. The lower portion of the frame, under the table, supports the lower shaft and wheel, which is driven by the pulleys *D*. The two wheels have a flange, against which the back of the saw bears, and the faces of the wheels are covered with vulcanized rubber resting on a bedding of strong cloth. This gives sufficient adhesion to the saw to insure its action as a belt without slipping.

From the front of the upper frame depends a vertical bar *E*, sliding in boxes, to which it may be secured, at any hight required to accommodate the stuff to be sawed, by the thumb-nuts *F*. On the lower end of the bar is a guide *G*, having four sides with recesses of varying depth, to accommodate the various width of different saws. This guide is in two parts, held together by a screw-bolt, and graduated in the distance of their faces by means of the screw-bolt and a four-pronged spring. The saw runs at the rate of 4,000 feet per minute.

In the English practice, the minimum diameter of band-saw pulley is set at 30 inches; but for wider saws the diameter must be increased: thus saws of 2 inches to 3 inches wide ought not to be worked over pulleys of less than 42 inches in diameter, and for a blade 6 inches wide the pulleys should be 70 to 80 inches.

Band-wheel. (*Machinery.*) This is sometimes termed a pulley, — a term which has, however, particular relation to tackle. The band-wheel has a nearly flat or a grooved face, according to the shape

Fig. 555.



Band-Wheel.

of the band. If it be flat, the face of the pulley is slightly rounded so as to keep the band from running off. If the band be round, the pulley is grooved to retain it, as in the wheel on the mandrel of the common foot-lathe.

Ban'gle. 1. (*Nautical.*) The hoop of a spar.

2. An ornamental ring, worn upon the arms or ankles in Asia and Africa.

Ban'gra. (*Fabric.*) A coarse Indian cloth, made from the fiber of a gigantic stinging-nettle.

Ban'is-ter. 1. (*Architecture.*) Originally, *baluster*. One of the vertical supports of a hand-rail on a balcony or stairs. Also the *hand-rail* itself. "He ascended, holding on by the banisters."

The baluster has a curved outline, and is frequently provided with a base and cap, or ornamental moldings, while banisters may be plain or square.

2. A broad central upright in a chair-back.

Ban'jo. 1. (*Music.*) A five-stringed musical instrument having a head and neck like a guitar, and a body like a tambourine, consisting of a circular frame over which sheepskin or parchment is stretched; it is of almost universal use among the negroes in the Southern States. Its simplicity, and the ease with which it is made and played, no doubt made it such a general favorite among them. Its thrumming sound has a near resemblance to the *tam-tam* of the Africans and the Orient. The latter is a lizard's skin stretched over a gourd; a tambourine, a sort of drum.

The guitar appears in the sculptures of ancient Egypt and Nimroud, and is much used in modern Oriental countries.

In the *kermanjeh*, or Syrian fiddle, the bridge-piece is supported upon the parchment cover of the body.

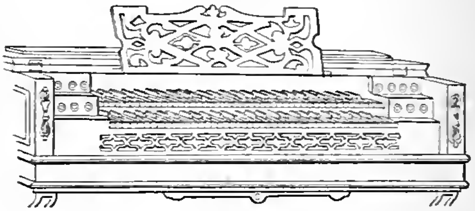
2. (*Nautical.*) The brass frame in which a screw-propeller is hung for hoisting.

Bank. 1. (*Cotton, etc.*) A creel for holding rows of bobbins; a *copping-plate* or *copping-rail*.

2. (*Glass.*) The floor of a glass-melting furnace.

3. (*Music.*) A bench of keys of a stringed or wind instrument. Generally applied to organs which have

Fig. 556.



Double Bank.

several key-boards or banks of keys belonging to the different aggregated organs, which combine to form an instrument of great power.

Such instruments are made up of a *choir* organ, *great* organ, and *swell*, to which may be added a *pedal* organ or *foot-keys*, for acting on the larger pipes. Each of these is adapted for particular effects: the *choir organ* for light and solo parts; the *great organ* for powerful effects; the *swell* for *crescendo* and *diminuendo* effects. Each has its key-board, one rising above another in front of the performer, and all within convenient reach.

The keys are thus arranged in three *banks* or tiers in the case described, and the keys of one bank, by a suitable device which may be thrown in or out of action as desired, may be *coupled* to the corresponding keys of another bank, so that the pressure on one is communicated to the other, to give the combined effect with a single manipulation.

Church reed-organs on a smaller scale and of portable size are frequently double-banked, the keys of one bank being concerned in the use of a powerful set of stops, and those of the other with other stops of a more mellow and moderate tone. See STOP; ORGAN.

The organ of S. Alessandro in Colonna, at Bergamo, built by Serassi in 1782, has four banks of keys and 100 stops. The first and second bank belong to the great organ and choir organ; the third is connected by mechanism, which passes underground to a distance of 115 feet, to a third great organ in another part of the church opposite the first.

The *claviers* of the Continental European churches are frequently fixed in a detached upright console, at which the organist sits facing the altar and congregation, so as to be able to watch the service and introduce the music at the proper times.

4. (*Mining.*) The face of the coal at which miners are working.

5. (*Nautical.*) *a.* One tier of oars in a *galley*. When a galley is propelled by rowers seated on two or more tiers of benches, one above another, the galley is said to be *double-banked*, *triple-banked*, etc.

b. A seat for rowers in a galley; a *thwart*.

Common galleys have 25 banks on a side, one oar to a bank and four men to an oar. *Galeasses* have 32 banks on a side, and six or seven rowers to a bank.

c. An oar is *single-banked* when it is rowed by one man. An oar is *double-banked* when pulled by two men, as the captain's barge. This term is also sometimes applied when separate oars are pulled by two men sitting on the same seat.

6. (*Printing.*) *a.* A wooden table for holding the paper to be fed to the hand-press. The paper is slipped off the *bank* on to a slanting board called the *horse*, from whence it is taken sheet by sheet.

b. The support of the moving carriage of a printing-press.

Bank-a-larm' Tel'e-graph. An apparatus for conveying to a director's room, or police, notice of surreptitious entering of the bank, or for conveying regular notices of "All 's well."

Bank'er. 1. (*Bricklaying.*) A bench used by bricklayers in dressing bricks to a shape suitable for skew or gaged work, domes, niches, etc. On one end of it is a grit-stone called a *rubbing-stone*, and on other portions is room for operating upon the bricks with the *tin-saw*, by which *kerfs* are made in the bricks to the depth to which they are to be hewn. An axe is used for dressing off the surface.

2. (*Fine Arts.*) A modeler's bench. It is about 30 inches high, and has a top 30 inches square. On this is a circular platform which turns on wheels, so that the figure can be revolved to expose any portion to the light.

3. (*Nautical.*) A vessel in the deep-sea cod-fishery on the Newfoundland Banks.

4. A seat cushion.

Bank'ing. 1. (*Engraving.*) Raising a wall of wax around an etching on a plate, to form an embankment to hold the acid used in *biting-in*. See ETCHING.

2. (*Steam-Engineering.*) Banking up the fires consists in raking them to the bridge of the furnace, and then smothering them with cinders and small coal, the draft being at the same time checked. By this means the fires are kept in a state of languid combustion, but are ready to burn up briskly again when steam is wanted at short notice, the red-hot mass being then broken up, raked forward, and the draft reädmitted.

The fire is said to be *drawn forward* when fuel is added and the draft turned on.

Bank-note. A promissory note issued by a bank, and intended to circulate as currency.

Chinese paper money was issued about A. D. 1100. "Blest paper credit," as Byron says. Genghis Khan issued paper money, but all his power could not give it a purchasing value above fifty per cent of its face.

In "The Book of the Balance of Wisdom," by Al-Khâzinî, a learned Arab of the twelfth century, occurs the remark that, in the first division of his book, are "added chapters on exchange and the mint, in connection with the mode of proceeding, in general, as to things salable and *legal-tenders*."

The Bank of England commenced business at Grono's Hall, Poultry, London, in 1695. No notes were issued under £20.

Notes of £5 were issued in 1793.

Bank-note En-grav'ing. The chief object in the manufacture of bank-notes is to render forgery impossible, or at least easy of detection. This is sought to be effected by peculiarity of paper, design, and printing; or by a combination of these means, as is done in the Bank of England and other banks. The mechanical design, however, has chiefly been relied on for security. It has been the constant aim to make the impression such as to render the genuine note readily distinguishable by the public for its high art, and to the bank officials by secret peculiarities in its execution. Until about 1837, copper-plate printing was the only process in use for bank-notes. In that year, however, PERKINS effected his valuable improvements in practical engraving. In 1855, electrotype printing was introduced in the Bank of England by Mr. Smee, and since that time the notes have been produced by surface-printing by the electrotype.

The design is engraved in relief on separate pieces of metal, — copper, brass, and steel. From the aggregated pieces a matrix is obtained by electro-deposition, and from this a plate is obtained by the same means. When backed and mounted the plate is used for surface-printing.

In America and in the Bank of Ireland, the plates are prepared according to PERKINS's method. The separate designs forming the complete bank-note are first engraved by hand on separate steel blocks, which are afterwards hardened, and are preserved as permanent patterns not to be printed from. These engravings are transferred to the steel rollers under heavy pressure, the rollers being afterwards hardened and used as dies to impress the engraving upon the printing-plates. The engraved plates for printing the bank-note are made of soft steel, and are never hardened after being engraved. Being of large size, — 20 inches by 16 inches, — they would most probably lose their flatness in hardening. Another reason for not hardening the plates lies in the fact that, when worn, the soft plates are easily repaired by re-application of the rollers thereto.

The printing-plate, when receiving its first impression from the master roller or die, is fixed upon the table of a strong press, from which a pressure of 10,000 pounds can be obtained, the pressure being regulated as required by means of a weighted lever. The position of two register-points in the plate is accurately noted by means of a micrometer microscope, and registered in a book kept for the purpose. The master-roller is then passed over the plate by the machine under the heavy pressure, being very steadily guided by a special parallel-motion arrangement. The table is provided with complete adjustments of peculiar delicacy, and the pressure of the engraving roller upon the plate is not produced by the roller descending upon the plate, but by the table being raised up to the roller.

When a plate requires renewing, it is again fixed upon the table in the same position as before by means of the micrometer microscope and the register of its position; the roller being passed over it deepens those parts of the impression which the continuous printing has worn away.

Bank-pro-tec'tor. (*Hydraulic Engineering.*) To prevent the washing away of banks by the action of waves or currents. See FASCINE; GROIN; SHEET-PILING; CRIB; PITCHING; RETAINING-WALL; DIKE; SEA-WALL, etc.

Ban'ner. A small fringed flag, depending from its staff by cords attached to the ends of a cross-piece.

Ban-quette'. 1. (*Fortification.*) A raised bank at the foot of the interior slope of a parapet, on which the soldier stands to deliver his fire. See INTRENCHMENT; ABATTIS.

A banquette is also found in some fortifications at the foot of the counterscarp, to enable defenders to fire over the crest of the glacis.

2. (*Civil Engineering.*) *a.* A raised footway adjoining the parapet of a bridge.

b. A ledge on the face of a cutting.

Ban'tam-work. Painted or carved work, resembling that of Japan, only more gaudy.

Bap'ta-te'rium. A back-mill or fulling-mill.

Bap'tis-ter-y. (*Architecture.*) A building appertaining to a cathedral or church, or a portion of the church itself, in which the ceremony of baptism is performed. If a separate building, the baptistery was, in the earlier ages, either hexagonal or octagonal in plan; afterwards they were made polygonal, or even circular.

When within the church, it is merely the inclosure containing the font, as in English churches of the present day.

Bar. A word of various signification in different branches of the practical arts; as

1. (*Hydraulic Engineering.*) *a.* A sedimentary deposit in a river, or at the embouchure of one.

b. A boom of logs preventing navigation.

2. (*Nautical.*) *a.* A lever used in a capstan. They are inserted like spokes in the capstan-head, and serve to rotate it. The analogous levers in a windlass are *handspikes*.

b. A flat iron rod securing a hatch.

c. A piece of iron or wood to secure a gun-port.

3. (*Machinery.*) *a.* A *bar-lathe* is one whose shear is a single piece, frequently triangular in section.

b. A large arbor supported between the centers of a lathe, and carrying the cutter by which a cylinder or gun is bored out. A *boring-bar.* See CYLINDER-BORER; BORING-MACHINE.

4. (*Mining.*) *a.* A drilling or tamping rod.

b. A vein running across a lode.

5. (*Weaving, etc.*) A *driving-bar* is a movable operating part in a lace-machine.

A *bar-loom* is a small-ware loom.

6. (*Printing.*) *a.* The portion connected with the handle of a hand printing-press, and acting to depress the platen.

b. The middle, long cross-piece of a printer's chase.

7. (*Husbandry.*) Shifting rails which are removable from their mortises in the posts are termed bars, and the complete device is a sort of substitute for a field-gate.

8. (*Saddlery.*) *a.* One of the side pieces uniting the pommel and cantle of a saddle-tree.

b. The mouth-piece of a bridle-bit which connects the two checks.

9. (*Furnace.*) *Grate-bars* or *fire-bars* support the fuel, and rest on *bearers*.

10. The *crowbar* is an iron lever used in many ways.

11. (*Carpentry.*) *a.* A horizontal piece of timber or metal connecting other portions of a framework.

b. A crosswise piece of wood or metal held by staples or bolts, and forming an inside fastening for door or shutter.

c. One of the thin strips of wood forming the divisions of a sash.

12. (*Vehicles.*) The piece to which the traces are attached; a *splinter-bar* is permanently attached to the carriage; an *equalizing-bar*, or *evener*, is otherwise known as a *double-tree*, swings on a pivot, and has a *single-tree* or *whiffle-tree* at each end.

Bar'an-gay. (*Nautical.*) An Indian vessel propelled by oars.

Bar'ba-can. (*Fortification.*) *a.* An advanced work to defend a bridge, gate, or approach. Otherwise, *barbican*.

b. An embrasure.

c. A channel or scupper in a parapet to discharge water.

Barb-bolt. (*Machinery.*) One having jagged edges to prevent retraction after driving; a *rag-bolt.*

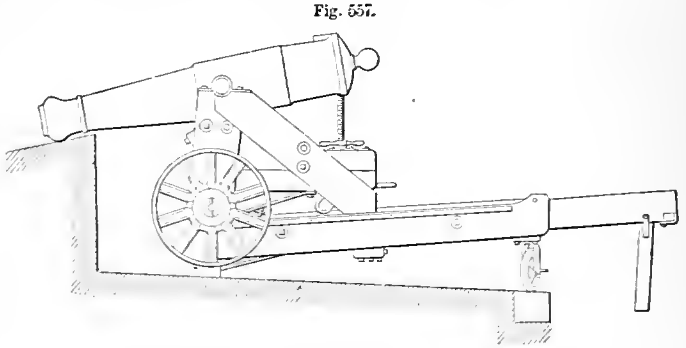
Bar'be-cue. In the Cingalese treatment of coffee-berries this is the dry floor on which coffee is sun-dried after the pulp is grated therefrom, and the beans in their parchment envelope have undergone a preliminary soaking. It is circular, of stone, with a white plaster surface, sloping away from the center, and smooth as glass. The coffee is sunned upon it for four days without removing the sac, in which a pair of berries are inclosed, the object being to dry it previous to being dispatched to Kandy.

Bar'ber's Chair. One adapted for the special uses of a barber, with a vertically adjustable head-rest, arms, an elevated footstool. In some barber's chairs there are drawers and shelves for the apparatus and appliances.

Bar-bette'-gun. (*Fortification.*) When a cannon is mounted so as to be fired over the crest of the parapet instead of through an embrasure, it is said to be mounted *en barbette.*

In field-works, a mound of earth is thrown up against the interior slope of the work; its upper surface is nearly level, and of such a hight as to allow the gun, mounted on its carriage, to be fired over the crest; a slope, termed a *ramp*, is made at the rear of the barbette, and descends to the *terre-plein*.

Fig. 557.



Barbette.

The parapet may be on the summit of a fort which has lower tiers of guns in casemate, or it may be a mere earthwork. The term *barbette* is from the French, as are almost all our military terms, and it means a work adapted to be fired over, and yields a certain amount of protection to the gunners, the piece, and the ammunition. The carriage is adapted to be run "in and out of battery" on a *chassis*, and the latter has a circular motion on a pintle, to enable the guns to be trained horizontally.

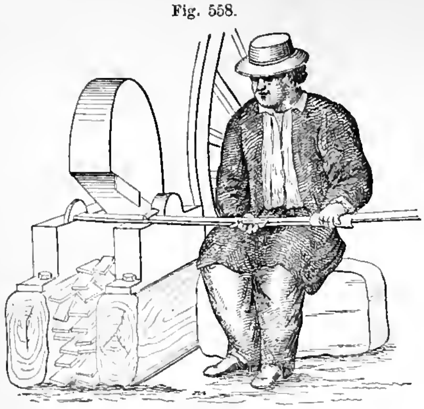
When the pintle is arranged at front, as shown in the figure, the amount of this circular motion is limited; on a center-pintle carriage the gun may be directed toward any point of the horizon. Such a gun is called a *pivot-gun.*

Bar'bi-can. See BARBACAN.

Bar'ca. (*Nautical.*) A Portuguese two-masted vessel. Used also in the Mediterranean. *Barcon.*

Bar-cut'ter. (*Metal-working.*) A shearing-machine which cuts metallic bars into lengths.

Fig. 558.



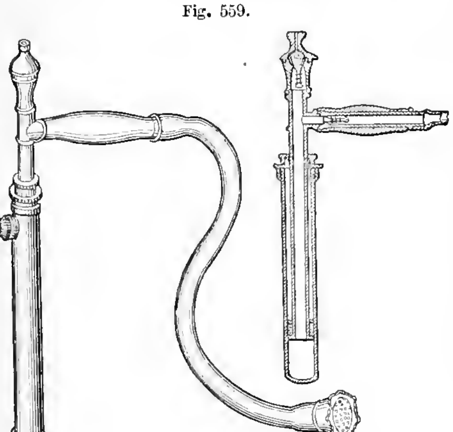
Bar-Cutter.

The purposes are various, — for cutting bars into pieces for fagoting and reheating, for nail-plates, etc.

Ba-rege′. (*Fabric.*) A lady's thin dress-goods, all wool, plain or printed. So called from *Bareges*, a town in the Pyrenees.

Bare-pump. (*Hydraulics.*) A portable suction-pump for drawing liquor from casks. Such are used in vinegar works, in wine and beer cellars, for

Fig. 559.



Bare-Pump.

sampling, etc. In the illustration the piston is hollow, and carries a spring-valve, which closes as the piston rises, and opens to allow the air to escape as the piston descends.

Bar-frame. (*Furnace.*) The frame which supports the ends of the grate-bars.

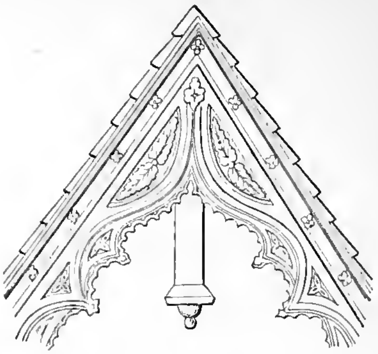
Barge. (*Nautical.*) *a.* A vessel or boat of state or pleasure; as the *Bucentaur*, the state galley of Venice; Cleopatra's galley; the Lord Mayor of London's barge, etc.

b. A man-of-war's boat next in size to the launch. The boat for the special use of the commander of a fleet or squadron is also called a barge. It is 30 to 32 feet long, has a beam equal to .29 to .25 of its length, is *carvel*-built, and carries from 10 to 12 oars.

c. A large boat for the conveyance of goods and passengers. In the United States they are frequently of 600 to 800 tons burden, have two upper decks, and are destitute of motive-power, being towed by steamboats.

Barge-board. (*Carpentry.*) A board beneath the gable, hiding the horizontal timbers. It is per-

Fig. 560



Barge-Board.

forated, scalloped, or crenated, to give it a light and ornamental appearance.

Barge-coup′le. (*Carpentry.*) A beam mortised into another to strengthen the building.

Barge-course. (*Architecture.*) *a.* That portion of the shingling or slating of a roof which projects over the gable-end.

b. A coping course of bricks laid edgewise and transversely on a wall.

Ba′ri. The portion of a roofing-slate showing the gage, and on which the water falls.

Bar′i-tone. (*Music.*) A kind of bass-viol.

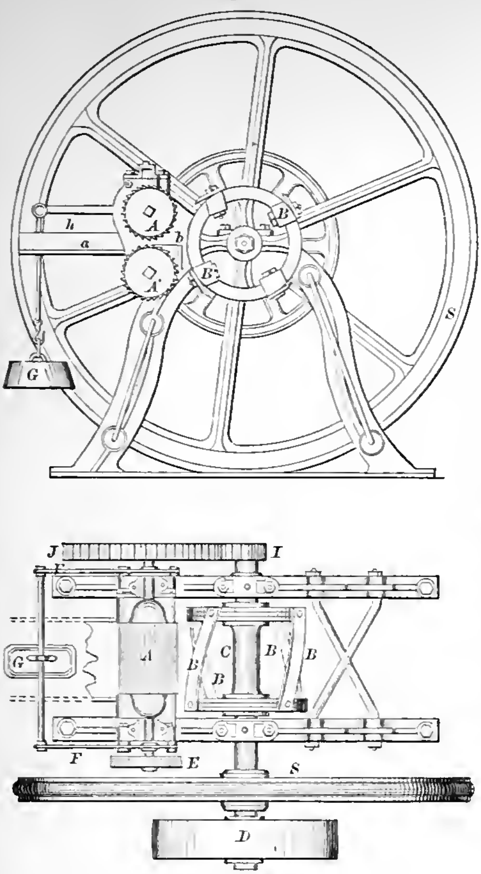
Ba′ri-um. A metal, the base of heavy spar (sulphate of baryta), discovered by Davy. It is of a grayish or yellowish hue, has only been procured in very minute quantities, and is rapidly converted into an oxide by the action of either air or water. It has never been applied to any practical use in the arts. Equivalent, 68.5; symbol, Ba. An oxide of barium, when reduced to a white powder, is used to adulterate white lead, and also as a cosmetic, — both very bad practices; one injures the paint, and the other the complexion.

Bark-cut′ting Ma-chine′. Bark is reduced to a state of minute division to enable the water to dissolve out the tannin more readily and perfectly.

FARCOT'S *Bark-cutting Machine* (French) is shown in side elevation and plan. *A A′* are two fluted cylinders which supply the bark previously spread upon the table *a* to the cutting-apparatus. *h* is a raised ledge to keep the bark on the table. The cutting apparatus consists of two parallel circles fixed upon a common axis *C*, having steel plates or knives *B B*, which are disposed in a spiral form. The shaft *C* and fly-wheel *S* are driven by a band on the drum *D*. A pinion at the other end of the shaft *C* carries a pinion *I*, which acts upon a wheel *J* on the axis of the fluted cylinder *A*, which is communicated by wheel *E* to cylinder *A′*. By the levers *F F* and weight *G*, the two cylinders *A A′* are regulated to any required proximity. Inside the fluted cylinders is a longitudinal piece of steel *b*, which acts as a support for the bark as it is cut by the knives *B B*, its edge forming, as it were, one bar of the cutting-shears.

The cylinder which carries the cutting-knives makes about 130 revolutions per minute, and the quantity of bark cut is about 1,600 pounds per hour.

Fig. 561.

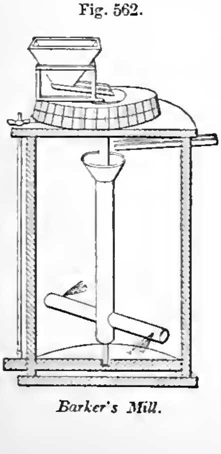


Bark-Cutting Machine.

Bark'er's Mill. (*Hydraulic.*) The Barker mill has attained celebrity rather as an interesting illustration of the principle of reaction or recoil than as a practically useful machine. It, however, has the essential features of the famous turbines and other reaction wheels.

It consists of a vertical tube having an open funnel at top, and branching at its lower end into two horizontal radial tubes. Each of these horizontal arms has a round hole on one side of it, the two holes being opposite to each other; and the vertical tube, being mounted on a spindle or axis, is kept full of water, flowing into the funnel at the top.

Fig. 562.



Barker's Mill.

The issue of water from the holes on opposite sides of the horizontal arms causes the machine to revolve rapidly on its axis with a velocity nearly equal to that of the effluent water, and with a force proportionate to the hydrostatic pressure due to the vertical column and to the area of the apertures; for there is no solid surface at the apertures to receive the lateral pressure which acts with full force on the opposite side of the arm.

According to Dr. Robinson, this unbalanced pressure is equal to the weight of a column having the orifice for its base, and double the depth of the water in the trunk for its hight.

The machine has, for one hundred years, been a favorite subject with writers on dynamics, and has been modified by mechanicians.

De la Cour (1777) proposed to bring down a pipe from an elevated reservoir, and, recurving its lower end upwardly, introduce the water into a short pipe with ten arms which revolved in a horizontal plane in the manner described.

The revolving arms may be mounted on a horizontal axis so as to obtain the requisite direction of motion without intermediate gearing.

In 1841, Whitelaw obtained a patent for an improvement, in which the horizontal arms assumed the form of the letter S. In this machine the water is discharged tangentially, the capacity of the arms being greater as they approach the center of rotation, so as to obtain a quantity of water at every section of the arm inversely proportionate to its velocity at that section. The transverse sections of the arms are everywhere parallelograms of equal depth, but of width decreasing from the central vertical pipe to the jet at the outer extremity of the arm.

A small machine of this description was constructed, having a fall of 10 feet, the diameter of the circle described by the ends of the arms being 15 inches, and the aperture of each jet 2.4 inches in depth by .6 inches in width, the area of each orifice being 1.44 inches, the water expended was 38 cubic feet, the revolutions 387 per minute, and the effect equal to 73.6 per cent of the power employed.

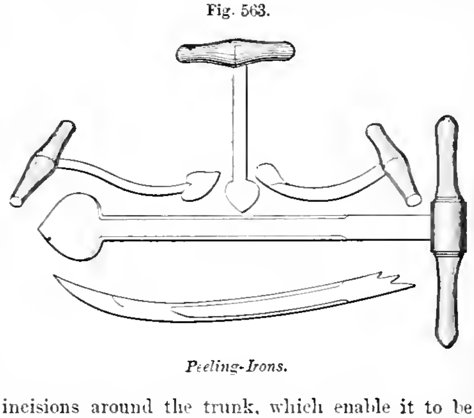
Bark'ing. 1. Coloring sails, nets, cordage, etc., by an infusion or decoction of bark.

2. Stripping trees of bark for cork, dye, tanning material, or medicine.

Bark'ing-axe. An axe of proportions and shape adapted for barking trees.

Bark'ing-tools. For removing the bark of trees for tanning purposes. Besides the axe or hatchet for slitting the bark longitudinally, and for cutting incisions around the trunk, which enable it to be removed in lengths, the barker requires *peeling-irons,* which are thrust beneath the bark to loosen it. The operation is performed in spring, when the sap is abundant between the bark and the wood.

Fig. 563.

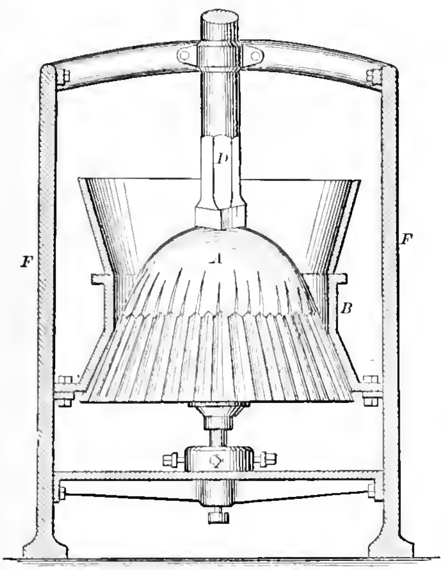


Peeling-Irons.

Rossing is not the exact equivalent of barking, as the former is a grinding or cutting action (usually), the latter a *peeling*. See Loudon's "Encyclopedia of Agriculture."

Bark-grind'ing Mill. WELDON'S *Bark-Mill*, 1797, has a conical iron drum *A* provided with teeth, and rotating in a casing *B*, the upper part of which forms a flaring hopper. The casing and its contained grinder are supported by a framing *F*, and motion is given to the cone by a belt running upon a drum on

Fig. 564.



Bark-Grinding Mill.

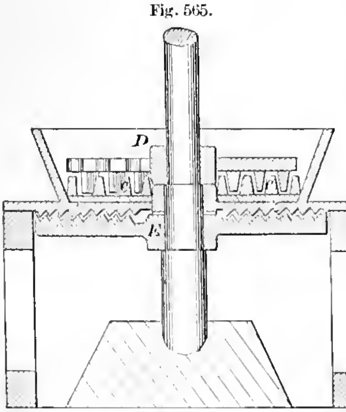
the upper end of the shaft *D*, whose lower end is supported in a step or ink. A screw below the step affords means for adjustment of the cone in the casing, the faces of the two being toothed, so as to effectually rasp the bark as it passes between their adjacent surfaces.

Bark'ing-mal'let. A short-handled mallet of hard wood. The face is three inches square, and the other end is sharpened to a *peen* or wedge.

Iron is a preferable material, and the same tool may be used for *ringing* the tree and splitting the envelope of bark longitudinally, so that it may be removed by the *peeling-iron*.

Bark-mill. In Fig. 565 the bark is broken between the breaker *D* and teeth *e*, thence passing between the rough-bottom surface of the hopper and the rotating disk *E*, by which it is reduced to powder.

Fig. 565.



Bark-Mill.

Bark-om'e-ter. A hydrometer so graduated as to determine the strength of ooze according to a given scale of proportions, water being zero.

Bark Pa'per. Throughout Southeastern Asia and Oceanica the *Broussonesia papyrifera*, or paper mulberry, is a common tree, and its bark is capable, by soaking and beating, of assuming the appearance of fine linen. It may be bleached, dyed, and printed, and is a common material for dress in the islands of Oceanica. In Java and Sumatra it is the common material for writing upon. When solidified and burnished, it resembles parchment. Manuscripts in European museums attest its quality. The same bark made into a pulp is used in China and Japan for making paper.

The processes adopted with bamboo and the mulberry-bark are substantially similar after the reduction of the raw material into a pulpy condition. The Chinese processes are as follows: —

The paper-stuff being rinsed with water alone, or with water in which rice has been boiled, is brought to the state of pulp, and then transferred to a vat having on each side of it a drying-stove in the form of the ridge of a house; that is, consisting of two sloping sides touching at top. These sides are covered externally with a smooth coating of stucco, and a flue passes through the brickwork, so as to keep the whole of each side equally and moderately warm. A vat and a stove are placed alternately in the manufactory, so that there are two sides of two different stoves adjacent to each vat. The workman dips his mold, which consists of a sieve-like bottom and a movable raised frame surrounding it, into the vat, and then raises it out again; the water runs off through the perforations in the bottom, and the pulpy paper-stuff remains on its surface; the frame is then removed, and the sieve is pressed bottom upward against the side of one of the stoves, so as to make the sheet of paper adhere to its surface and allow the sieve to be withdrawn. The water speedily evaporates by the warmth of the stove, and before the paper is quite dry it is brushed over on its outer surface with a size made of rice; this also soon dries, and the paper is then stripped off in a finished state, having one smooth surface, it being the practice of the Chinese to write only on one side of the paper. While this is taking place, the molder has made another sheet, and pressed it against the side of the other stove, where it undergoes the operation of sizing and drying, as the other had done. If sheets of very large dimensions are to be made, the mold is suspended by a tackle and is managed by two men; but in other respects the process is the same as that just described.

Exceedingly beautiful paper is produced by this very simple method. Paper is made in India in much the same way and with nearly the same materials; but in the provinces north of the Ganges, and in Nepal, the common material is the bark of a species of *Daphne* (laurel), which, like that of the paper-mulberry, consists almost wholly of fiber.

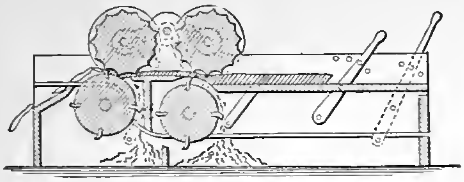
Another mode adopted by the Chinese is to dip out the pulp in a mold made of strips of bulrushes in a frame. The sheets from the frames are piled on a table with intervening strips of reed, by which they may afterwards be lifted leaf by leaf. Each heap is pressed by boards and weights to express the water, and the following day, the leaves, being lifted singly, are laid on a plank in the sunshine to dry.

Bark-pit. (*Tanning.*) A pit partly filled with bark and water, in which hides are steeped in the process of tanning.

Bark-plan'ing Ma-chine'. A machine in which the layer of bark is subjected to the action of consecutive cutters, to separate the inner and outer layers.

The bark is passed beneath the rollers with the rough side uppermost, and the first cutter removes the in-

Fig. 566.

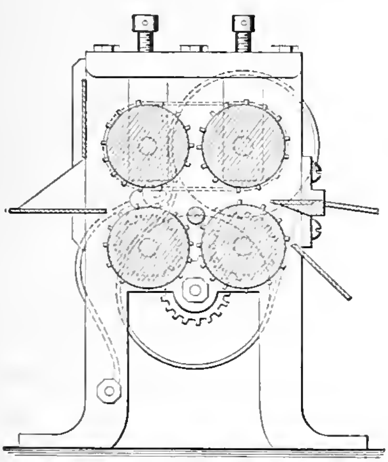


Bark-Planing Machine.

most bark, the second the inner portion of the outer bark, the extreme outer portion of the bark being discharged from the machine down the incline to the left. The dust removed by the respective cutters falls into separate receptacles.

Bark-ross'ing Ma-chine'. A machine for removing the *ross*, — that is, the rough, scaly portion from the outside of bark. The ross has a lesser proportion of tannin, and by its removal a steep of greater strength may be obtained and vat-room saved.

Fig. 567.



Bark-Rossing Machine.

In the example (Fig. 567), the machine consists of two pairs of toothed rollers which feed in the bark and thrust it against the stationary knife, which divides the *ross* from the liber, and the separated portions slide down different inclines to special receptacles.

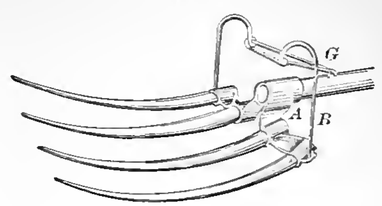
Bark-stove. (*Horticulture.*) A bed of spent bark and soil, heated by flues or steam-pipes, aided by a slow fermentation of its materials. It is used to make a bottom heat for plants growing in pots which are plunged therein.

Bar-lathe. (*Turning.*) A lathe whose beam or shear consists of a single bar on which the puppets or stocks and the *rest* are arranged. The bar is generally of a triangular shape in cross section, one flat side downward.

Bar'ley-chump'er. (*Agriculture.*) A machine for breaking the awn from the grain. (Prov. English.) A *hummeling-machine.*

Bar'ley-fork. (*Agriculture.*) A fork specially adapted for gathering up the unbound gavels of barley or other grain, the stalks of which are too short to be readily made into sheaves. For this purpose it is provided with an upright arrangement, as *B*, at the base of the tines. In the example shown, the

Fig. 568.



Barley-Fork.

tines and handle are attached to the metallic socket-head *A*, the whole being braced and supported by the bow *B* and brace *G*.

Bar'ley-hul'ler. (*Milling.*) A machine for taking the hull or cuticle from the grain of barley, making *pot-barley* or *pearl-barley*. The former has merely lost the cuticle, the latter has had a further amount of its substance removed by prolonging the process for double the length of time. The process is analogous to that of *hominy-making*. See HULLING-MACHINE; HOMINY-MACHINE.

Bar'ley-mill. (*Milling.*) A mill for decorticating barley; bringing it to the condition known as *pearl*-barley, the husk or the rind of the seed being removed. There are several ways of accomplishing this: 1. By the usual English barley-mill, — a stone roughened on its circumference, and revolving in a metallic casing with holes like a grater pointing inward and upward.

2. By so regulating the distance between the ordinary runner and the bed-stone that the grain is not mashed, but merely the bran rubbed off.

Bar-loom. (*Weaving.*) A loom for weaving ribbons.

Barm. (*Brewing.*) The foam or froth rising from malt liquors; yeast.

Bar-mil'li-ans. (*Fabric.*) An old name for a kind of fustian goods largely exported from England.

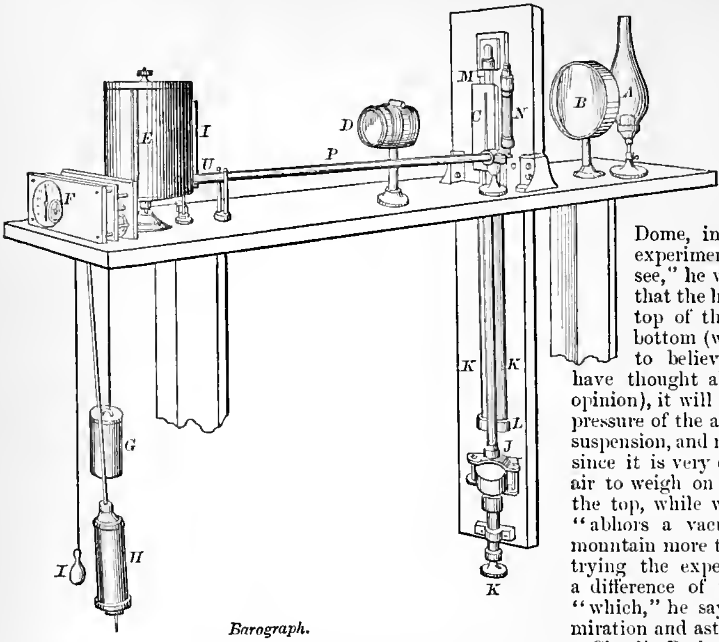
Bar'na-cles. (*Menage.*) A noose attached to a stock or handle, and nipped around the upper lip of a horse. It is twisted so as to be somewhat painful, in order to give the command of the head to the person holding the same. It enables a man to hold the horse's head aloft to keep him from biting, occupy his attention, and measurably prevent his kicking.

Bar'o-graph. An instrument for recording automatically the variations of atmospheric pressure.

In Fig. 569 this is effected by means of photography. The operative and recording parts are inclosed in a case (which in the figure is supposed to be removed) which rests upon the horizontal slab, and entirely excludes the entrance of light except through the slit *C*. *A* is a gas-burner, the light from which is thrown by the condenser *B* over the top of the mercurial column in the barometer-tube *J*, and passing through the photographic lens *D*, is concentrated on a strip of sensitized paper wound around the cylinder *E*, which is, by clockwork mechanism at *F*, made to revolve once in forty-eight hours.

The image of that portion of the slit *C* above the mercurial column is thus caused to form a continuous dark band of irregular width on the paper, becoming narrower as the mercury rises, and widening as it descends in the tube, the width of the band indicating not only the relative changes, but absolute hight of the barometer. A shutter operated by the clock-work cuts off the light for four minutes at the end of each second hour, leaving a vertical white time-line on the paper.

Fig. 569.



Barograph.

By the expansion of a zinc rod on each side of the barometer-tube, in connection with a glass rod and lever, thermometric changes are made, and the true barometric changes, with corrections for temperature, are photographically recorded.

Brooke's Self-Registering Barometer. Upon the column of mercury is a float carrying a mirror, on which a pencil of light is thrown. The case is inclosed so as to exclude all other light, and the beam is reflected by the mirror upon a traveling slip of paper indicating the extent and time of barometric changes.

Ba'ro-ma-crom'e-ter. An instrument for ascertaining the weight and length of infants.

Ba-rom'e-ter. (*Meteorology.*) An instrument for determining the weight or pressure of the atmosphere. Invented by Torricelli about the year 1643.

Barometers are variously named from differences in construction, mounting, fitting, etc. ; e. g. : —

Aneroid.	Minimum barometer.
Holosteric barometer.	Mountain barometer.
Hypsometer.	Pediment barometer.
Long-range barometer.	Self-registering barometer.
Marine barometer.	Sympiesometer.
Maximum barometer.	Wheel barometer.

It is related that the pump-makers of Cosmo de Medici tried to raise water over 32 feet by means of a sucking pump, but failed to raise it over 31 feet. They applied to Galileo to resolve the difficulty. He was unable to do it, but bade them accept the fact. His disciple Torricelli investigated the subject, and found that the force, whatever it was, raised a column of mercury only 30 inches, which he judged to be the equivalent of the 31 feet of water, and hence deduced that the moving agent was not a nameless "horror of a vacuum," — a term which covered the ignorance of the real cause, — but was the pressure of the air upon the liquid ; and that this pressure was equal to about 15 pounds to the square inch.

In 1647, Pascal showed practically that the hight of the mercurial column was affected by carrying the inverted tube to the top of an eminence. He made the experiment on a church-steeple in Paris. To test the matter more completely, he wrote to his brother-in-law Perrier, who lived near the Puy de Dome, in Auvergne, to repeat the experiment on that mountain. "You see," he writes, "that if it happens that the hight of the mercury on the top of the hill be less than at the bottom (which I have many reasons to believe, though all those who have thought about it are of a different opinion), it will follow that the weight and pressure of the air are the sole cause of this suspension, and not the horror of a vacuum ; since it is very certain that there is more air to weigh on it at the bottom than on the top, while we cannot say that nature "abhors a vacuum" at the foot of a mountain more than on its summit." On trying the experiment, M. Perrier found a difference of three inches of mercury, "which," he says, "ravished us with admiration and astonishment."

Claudio Beriguardi, at Pisa, is said, however, to have used the barometer for determination of hights five years earlier than this. It is certain that the varying weight of the atmosphere at different hights was known before Torricelli.

Alhazen the Saracen, A. D. 1100, was aware that the atmosphere decreases in density with increase of hight, and therefrom explained the fact that a ray of light entering it obliquely follows a curvilinear path, which is concave towards the earth. He showed that a body will weigh differently in a rare and in a dense atmosphere, and calculated that the hight of the atmosphere is nearly 58½ miles, anticipating the discovery of Torricelli by several centuries. "The Book of the Balance of Wisdom," by Al Khazini (perhaps the same as Alhazen), gives a number of other luminous statements on mechanics. We take the liberty here of stating that he also wrote on the doctrine of the progressive development of animal forms, but did not reach the Darwinian conclusion. "Not," as he says, "that man was once a bull, and was then changed into an ass, and afterward into a horse, and after that into an ape, and finally became a man." This, he states, is only a misrepresentation by "common people" of what is really meant.

There is yet some difference between the true theory of progression and the doctrine of the Vedas, the Institutes of Menu (contemporary with Elijah and Homer, and the teaching of Pythagoras, 540 B. C. Rosalind, the charming, refers to the latter, apropos of finding the poetry tacked to the palm-tree : —

"I never was so berhymed since Pythagoras' time that I was an Irish rat, which I can hardly remember." — *As you Like It.*

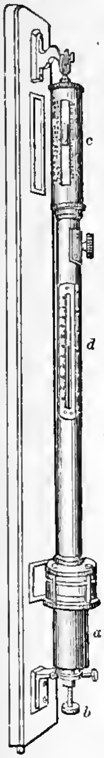
The pious Moslem prays that the All-Merciful will, in the Day of Judgment, take pity on the soul of Abu-r-Raihân, who first compiled a table of specific gravities, the discovery of the great Archimedes thirteen hundred years before. Our own Draper desires to add a clause associating in this prayer the name of "*Alhazen,* who first traced the curvilinear path of a ray of light through the air." It would not be hard to find good reason for associating the name of Draper with the illustrious two.

The barometer in its ordinary form consists of a tube 34 inches in length, closed at the top, exhausted of air, and with its lower open end plunged in a cup of mercury which ascends in the tube by the pressure of the atmosphere. Changes in the weight of the atmosphere raise or lower the hight of the mercurial column ; and a graduated scale alongside the tube, and embracing the range of motion, enables the reading of the variations.

The wheel barometer has a recurved tube in which the mercury ascends and descends, thereby actuating a float which connects by a cord to the axis of an index-finger, which rotates on a graduated dial. It was contrived by Hooke in 1688, the year that the great Dutchman, William of Orange, came to England.

The pendent or marine barometer is suspended on gimbals, which enable it to maintain its verticality during the rolling and pitching motions of a ship, and has a contraction at the bottom of the tube to obviate oscillations of the mercury. It was introduced about the year 1698 – 1700.

Fig. 570.



Standard Barometer.

The invention of the aneroid barometer is attributed to Conti, 1798, or to Vidi, 1804.

In the aneroid barometer (which, as its name implies, has no liquid) the pressure of the atmosphere is exerted upon an elastic metallic diaphragm above a chamber partially exhausted of air. The motions of the diaphragm, due to changes of pressure, are transferred to an index-finger which traverses in connection with a graduated scale. See ANEROID.

Barometers have been constructed in which the tube and cistern were filled with water instead of mercury. The great length of the column (nearly 34 feet at ordinary pressures) renders it extremely susceptible to slight atmospheric changes ; so much so that even momentary fluctuations can be observed at times during storms : but the difficulties in constructing and keeping in adjustment a barometer of this kind have prevented its coming into practical use. It would obviously be useless at temperatures below 32° F.

A standard barometer is one made with peculiar care, to serve as a standard of comparison for less costly instruments of the kind, or for use in meteorological observations, etc., where great accuracy and susceptibility are desired. The tube has in some cases a bore of an inch or upward.

a is the mercury-cup, *b* the adjusting screw, *c* the vernier, *d* the thermometer for data in making the corrections for temperature.

In reading the barometer two corrections are necessary : —

1. For the *capillarity,* or depression of the mercury in the tube.

2. For the temperature.

Pure mercury in a glass tube assumes a convex surface, and the convexity is greatest in tubes of small diameter.

The following is Ivory's scale, giving the corrections for tubes of different diameters : —

Diameter of Tube. Inches.	Depression. Inches.	Diameter of Tube. Inches.	Depression. Inches.
.10	.1403	.40	.0153
.15	.0863	.45	.0112
.20	.0581	.50	.0083
.25	.0407	.60	.0044
.30	.0292	.70	.0023
.35	.0211	.80	.0012

In siphon barometers, as the depression is equal in each leg of the tube, no correction is necessary.

The correction for temperature involves the consideration of the expansion of the mercury and also of the graduated scale. The latter, being minute, is, however, generally disregarded, and that of the mercury being .0001001 for each degree Fahrenheit, it has been usual to subtract from the reading $\frac{1}{10000}$ of the observed altitude for every degree of Fahrenheit above 32°. An example of the correction will stand thus : —

Thermometer, 54°.

Barometer, 30 inches.

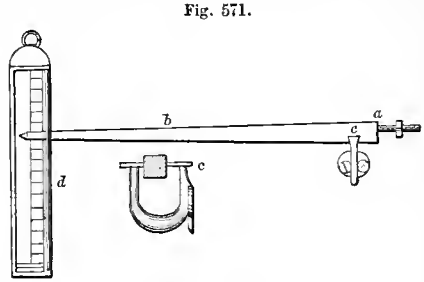
$(54 - 32) \times 30 \times .0001 = .066$, to be subtracted from 30 inches. Result, 29.934 inches.

Calculated correction tables are published.

The holosteric barometer is one in which a fluid is dispensed with. The usual form is the ANEROID (which see). The Vidi aneroid has a metallic diaphragm ; the Bourdon aneroid has a bent tube capable of flexion. See BOURDON BAROMETER.

A form of holosteric barometer is constructed on a principle similar to that of the *hygrometric balance.* Its action depends on the different specific gravities

Fig. 571.



Balance Barometer.

of a short metallic arm *a* and a long and bulky wooden arm *b*, balanced on a pivot *c* at their common center of gravity ; the long wooden arm, displacing a greater bulk of air in proportion to its weight than the other, is depressed by the rarification and elevated by the condensation of the atmosphere, causing the two arms to oscillate about the sustaining pivot, the variations being shown by a scale *d*, to which the longer arm points.

From a manual compiled by Rear-Admiral Fitzroy of the English navy, and published by the Board of Trade, the following is condensed : —

The barometer shows changes in the weight of the atmosphere, if any occur.

Changes in the level of the mercury are more emphatic than actual elevation.

If the mercury, standing relatively high, should fall, it presages a change, but not so great a one as if the mercury stood lower and fell to the same extent. The converse is also true.

The barometer foretells coming weather rather than indicates the present. The longer the interval between the sign and the change, the longer said altered weather will last. The converse is also true.

The barometer being at medium hight and rising, the thermometer falling indicates dry weather. The converse: barometer medium and falling, thermometer rising, rain; thermometer falling, snow.

The rising or falling condition of the mercury may be observed upon its upper surface; convex if rising, concave if falling.

Fluttering changes indicate unsettled weather; slow movements the contrary. Rapid and continued fall is a sign of a storm, the wind being from the north if the barometer is low (for the season), and from the south if the thermometer is high.

Three causes affect a barometer: —

1. The direction of the wind.
2. The moisture of the air.
3. The force of the wind.

When they act separately they act less strongly, and when coincidently the change in the barometer is greatest.

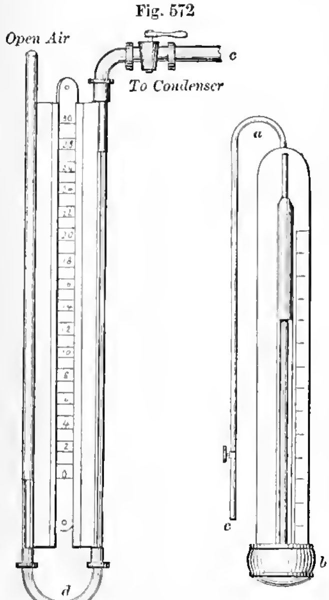
Ba-rom'e-ter-gage. (*Steam-Engine.*) An attachment to a boiler, condenser, or other chamber, which indicates the state of the vacuum.

When a boiler is allowed to cool, the steam condenses, and a more or less perfect vacuum is formed therein, subjecting the boiler to heavy external atmospheric pressure. This contingency is usually met by an inlet safety-valve, called a *vacuum*-valve.

When a condenser is in operation, it is desirable to know the condition of the vacuum, as a test of the efficiency of the air-pump.

When a receiver is partially exhausted for experimental purposes, it is desirable to obtain an indication of the tenuity of the contained air.

Fig. 572



Barometer-Gages.

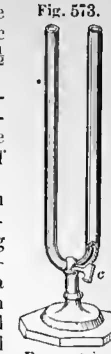
The *Barometer-gage* is a bent glass tube *a*, one end being plunged in a cistern of mercury *b*, and the other end *c* connecting with a steam-boiler, condenser, or tank, as the case may be.

When the jet of water condenses the steam in the condenser, a partial vacuum is formed, and the external atmosphere is in excess of the internal pressure, so that the mercury is caused to ascend the tube.

Another form is an inverted siphon, the mercury being contained in the bend *d*, as in the *Steam-Pressure Gages.*

Bar-o-met'ri-cal A-e'ri-om'e-ter. (*Meteorology.*) An inverted siphon used for approximately determining the relative specific gravities of immiscible fluids, as oil and water, or water and mercury. For instance, if mercury be poured in one limb and water into the other, and the stop-cock at *c* be turned so as to establish a communication between them, it will be found that an inch of mercury in one limb will balance 13½ inches of water in the other, showing the relative specific gravities of the two fluids to be as 13½ to one.

Fig. 573.



Barometrical Aeriometer.

Bar-o-met'ro-graph. (*Meteorology.*) An instrument by which the variations of atmospheric pressure are automatically recorded on a sheet of paper.

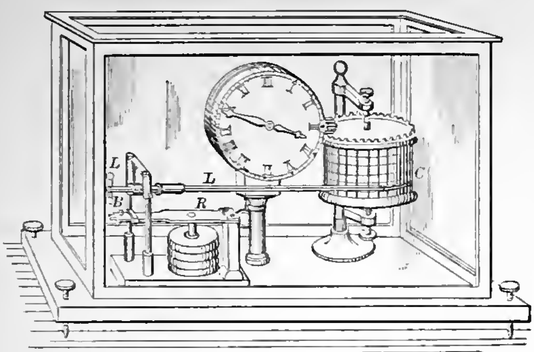
Napier's instrument, patented in 1848, is intended to mark the variations of atmospheric pressure during an entire period of 24 hours. Connected with the barometer-tube is a vertical spindle carrying a card which has on its surface a number of radial lines and concentric circles; the radial lines represent fractions of inches, and the concentric circles represent portions of time. Above the card is a lever carrying a vertical pricker, which is made to rise and fall at certain regular intervals of time, and to travel from the inner concentric circle to the outer one once in 24 hours. On the vertical spindle, and underneath the card, is fastened a grooved wheel, around which is passed a cord, while the other end is made fast to a float resting upon a column of mercury in a tube. The card has a fixed point representing 29.5 inches, which, at the commencement, is placed underneath the pricker. As the column of mercury rises or falls by the varying pressure of the atmosphere, the printed card will tiavel to the left or the right accordingly; and the variation of hight will be indicated by the distance of the punctured lines from the starting-point on either side.

A self-registering barometer, recently invented in France, is shown in the accompanying cut. The records are continuous and comparable, and are produced by the variations of an aneroid. The pressure of the atmosphere affects four metallic boxes, as in the ordinary aneroid, having their upper and under faces undulated; a vacuum is made in each of them separately, and they are attached together in one series, so that for an equivalent variation of pressure the movement is four times greater than it is for one box only. A very strong flat steel spring *R* acts upon the barometric boxes in an opposite direction to the atmospheric pressure. This spring controls the indicating lever *L L* by means of a connecting piece at the point *B*; this connector receives the action from the extremity of the spring, and communicates it to the lever *L L* at a point very close to its axis, from whence it follows that a considerable multiplication of movements is the result.

The indications of the movements of the lever are registered in the following manner: A cylinder *C* is revolved by the regular movement of an ordinary pendulum timepiece; it makes a complete revolution in one week, and carries a glazed paper which has been smoked black by means of a candle. At the extremity of the lever is a very fine spring, pointed at the end, which rests upon the cylinder and traces a white line upon the black ground. At the end of each week the paper is changed for a fresh one, the record on the old one being protected by a coat of varnish.

The action of the self-registering and printing barometer, invented by Professor Hough of the Albany Observatory, depends upon the making and breaking of an electric circuit by the rising and falling of the mercury, for the communication of impulses to electro-magnets, which unlock a train of clockwork so devised as not only to describe a constant curve upon a piece of paper, representing the hight

Fig. 574.



French Barometrograph.

of the column at any time of day and night for many days in succession, but also to print upon pages, which may be subsequently bound, the hights of the column as often as may be desired, thus making a printed record. The barometer employed has a siphon tube.

Bar'o-scope. (*Meteorology.*) An instrument which indicates the variations in weight of the atmosphere without indicating its absolute pressure. A weather-glass. Of this class are the instruments called prognosticators, or storm-glasses, consisting of a tube containing a clear liquid in which a flocculent substance floats, rising and falling with variations in the weight of the atmospheric column, and thus indicating the kind of weather which may be expected.

Somewhat allied to these are instruments in which a flocculent substance is suspended in a menstruum ; the assumption of a milky appearance by the material indicates an excess of moisture in the air, and prognosticates rain.

The wheel barometer of Hooke is also a baroscope, as its changes and indications are made visible by means of a float in the mercury, whose counterbalanced suspension-string moves a hand on an index-circle.

Ba-rouche'. (*Vehicle.*) A four-wheeled carriage, having a falling top. It has two seats inside, arranged so that four persons can sit two facing other two, the seat for the driver being outside.

Bar-pump. (*Hydraulics.*) A small boat-pump for raising water, oil, etc., from large casks. Probably from *Burr-pump.* See BARE-PUMP.

Bar-quan-tine'. (*Nautical.*) A three-masted vessel, square-rigged on the foremast, and fore-and-aft rigged on the main and mizzen. Commonly found on the Northern lakes. Also spelt *barkantine.*

Barque. (*Nautical.*) A three-masted vessel whose fore and main masts are *square-rigged,* like those of a ship, and whose mizzen is *fore-and-aft* rigged, like a schooner.

Bar'ra-can. (*Fabric.*) A thick, strong stuff, known by this and similar names in most of the languages of Europe and Western Asia. It is made in Armenia and Persia of camel's hair, like *camlet,* whose name also indicates that its material is derived from the same animal. The name has been preserved, while the fabric has been made of other materials, — wool, flax, and cotton.

It was during the wool stage that the memorable Falstaff celebrated his achievements : "Four rogues in buckram (*barracan*) set at me."

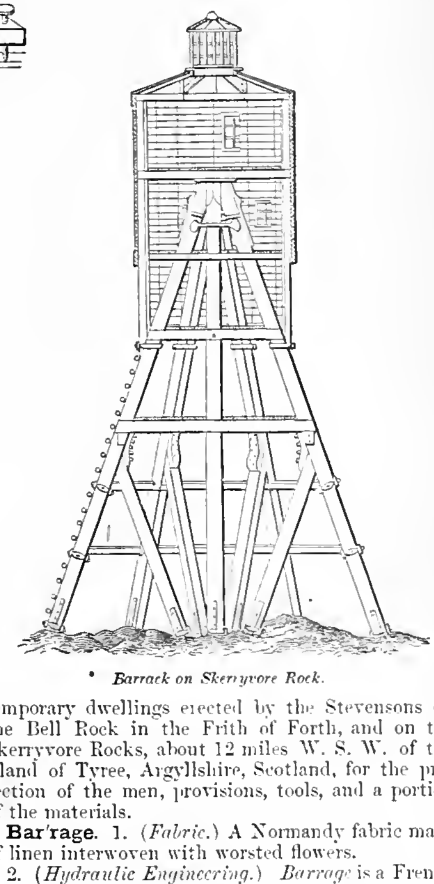
An article called *barracan* is yet used in Europe, and in some countries is mainly cotton, resembling *fustian.*

The old Roman toga was commonly made of this material.

Bar'rack. (*Engineering.*) A temporary building for quartering soldiers or for workmen. Permanent buildings, also, designed exclusively for occupancy by soldiers, are generally so called.

Also a structure erected for sheltering the workmen where work is progressing in an isolated position, to which access is at times difficult or impossible, on account of the state of the tide or weather. Of this class were the

Fig. 575.



Barrack on Skerryvore Rock.

temporary dwellings erected by the Stevensons on the Bell Rock in the Frith of Forth, and on the Skerryvore Rocks, about 12 miles W. S. W. of the island of Tyree, Argyllshire, Scotland, for the protection of the men, provisions, tools, and a portion of the materials.

Bar'rage. 1. (*Fabric.*) A Normandy fabric made of linen interwoven with worsted flowers.

2. (*Hydraulic Engineering.*) *Barrage* is a French word, signifying, in general, an artificial obstruction placed in a water-course in order to obtain an increased depth for navigation, irrigation, or other purposes. *Barrage-fixe* is a permanent dam of masonry. *Barrage-mobile* is a dam having a sluice by which the flow of water may be regulated.

Bar'ras. (*Fabric.*) A kind of packing-cloth.

Bar'rel. A word applied to hollow cylindrical objects, such as —

1. (*Pump.*) The piston-chamber of a pump.

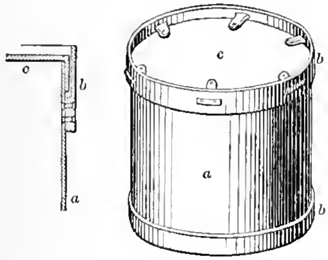
2. A cask for containing liquids, usually having a capacity of from 30 to 45 gallons.

A cask for certain kinds of provisions, — flour, fruits, vegetables, etc., — holding 196 pounds of flour (American custom), or about $2\frac{1}{2}$ bushels of fruit, varying according to the customary practice in regard to *striking* or *heaping* the measure.

A measure of ear-corn in the Southern States, shelling $2\frac{1}{2}$ bushels.

The DICKENSON Patent Wrought-Iron Barrels, used in the British navy, have a cylindrical form, with a soldered seam. An iron hoop *b* is riveted to each end. This hoop has a rabbet, and the thickest part is riveted to the drum *a*, while the other portion forms a recess with the side of the drum for the reception of the flange of the head *c*, which is made by bending the periphery of the circular iron plate at a right angle to its plane. A packing of greased hemp-bands is placed in the recess, the flange of the head driven in, and then the edge of the iron hoop is turned over against the bottom head, making an air and water-tight joint.

Fig. 576.



Dickenson's Wrought-Iron Barrel.

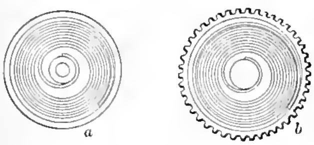
This is for the bottom head. The upper head is removable without damage to the package. The upper portion of the hoop is not flattened down as at the other end of the barrel, but a number of latch-bolts are pivoted to the cover, and catch into openings in the side of the hoop.

The metal is coated inside and out with canvas saturated with a composition of caoutchouc, 8; black resin, 4; Venice turpentine, 1.

This is digested, spread on the cloth, and the latter is then run between rollers.

3. (*Horology.*) *a.* The hollow cylinder or case containing the *mainspring* of a watch, or spring clock (*a*, Fig. 577). It is connected by a *chain* with the *fusee*, and by the winding of the latter the *chain* passes from the *barrel*, and the *mainspring* is *wound*. See FUSEE.

Fig. 577.



Barrels.

When the *fusee* cannot be introduced into a watch, owing to the flatness of the *movement*, the first wheel is attached to the *barrel*, which is then called a *going-barrel* (*b*, Fig. 577).

Stop-works are attached to regulate the action of the spring; that is, to prevent its being wound too tight or running down too far, using the middle power of the spring and rejecting its highest and lowest powers. This is particularly necessary in watches destitute of the *fusee*. See STOP-WORK.

b. The chamber of a spring-balance.

4. (*Fire-arms.*) The tube of a gun from which the projectile is discharged.

5. (*Music.*) The cylinder studded with pins by which the keys of a musical instrument are moved.

6. (*Metallurgy.*) A cylindrical vessel moving on an axis, for amalgamating, polishing (*tumbling-box*), or making gunpowder. In the latter case it is partially filled with bell-metal balls, and is called a *rolling-barrel*.

7. (*Nautical.*) *a.* The main piece of a capstan, between the *whelps* and the *pawl-rim*.

b. The cylinder around which the tiller-ropes are wound.

8. The sonorous portion of a bell, which is attached by the remaining portion, the *canon* or *ear*, to the suspensory arrangements.

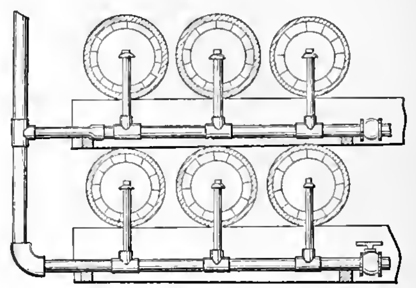
9. (*Pulley.*) The cylindrical portion of a drum or pulley on which the band laps.

10. (*Steam-Engine.*) The cylindrical portion of the locomotive boiler extending from the fire-box to the smoke-box.

Bar'rel-drain. A cylindrical drain.

Bar'rel-dry'er. A device for drying barrels after being coopered or washed, before refilling.

Fig. 578.

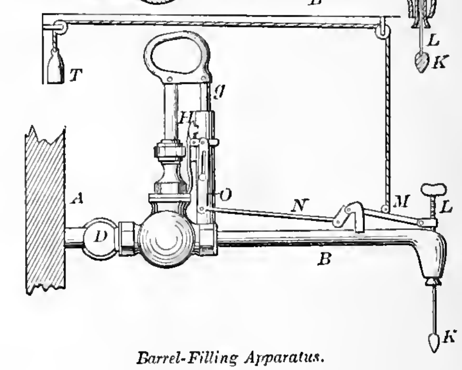


Barrel-Dryer.

The view (Fig. 578) is sectional, and shows two tiers of main steam-pipes with vertical branch-pipes extending upwardly through the bung-holes into the interiors of the casks.

Bar'rel-fill'er. (*Hydraulics.*) A device for filling casks, provided with an automatic arrangement for cutting off the supply of liquid in time to prevent overflow, or calling attention to the fact that the vessel is about full.

Fig. 579.



Barrel-Filling Apparatus.

In one form, the rising of the liquid in the barrel is the means of stopping the flow. In Fig. 579, the tube *A' B* is jointed at *D*. The end bearing the float

K is inserted into the barrel to be filled, and, as the float rises, it, through the medium of the rod *L* and jointed lever *M N O*, releases the detent *H*, allowing a spring to force up the rod *g* and depress the rod *e*, closing the valve *E* and cutting off the supply. As the projecting spout *B* is lightened by the absence of the liquid, the counterpoise weight *T* lifts it clear of the bung-hole.

In another form, the liquid flows through a stop-cock to enter the barrel; when the latter is full, the liquid overflows into a chamber in which a float rises and operates a lever to close the stop-cock.

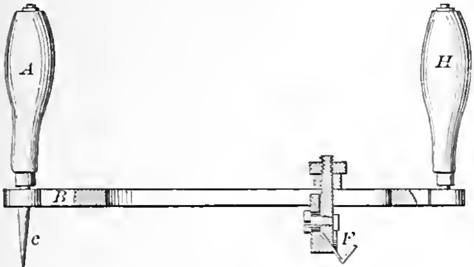
In another form, as the liquid rises and closes the air-exit, the air condensed in the upper part of the barrel passes through a duct in the faucet, and by pressure on a diaphragm operates a lever which closes the supply.

In some cases the elevation of the water-level operates a whistle, in another rings a bell. The ascending float, however, is the usual operative feature of the barrel-filler.

Bar'rel-fill'ing Gage. (*Hydraulics.*) An automatic indicator, used in connection with a faucet, to announce when the barrel is about full, so that the supply may be stopped. Some gages merely show the hight of the liquid in the barrel; others give an alarm when it attains a certain hight; others cut off the supply. See BARREL-FILLER.

Bar'rel-head Cut'ter. (*Coopering.*) *a.* A tool for rounding and chamfering barrel-heads. The

Fig. 580.

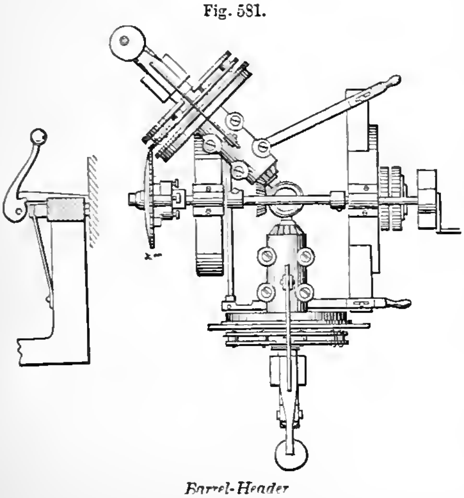


Barrel Head Cutter.

pivot *c* is stuck into the center of the head, and the tool rotated by the handle *H*. The angular cutter *F* is adjustable on the shank *B* of the tool, according to the radius of the barrel-head.

b. A machine for effecting the same purpose. In the example the blank is placed between the clamping disks, and the frame turned so as to bring the blank in contact with the disked saw; this movement also brings the bevel-wheel upon the arbor of the clamping-disks in connection with its motive-wheel upon the saw-shaft. The frame is duplicated, so that while one blank is being operated on, another may be clamped in position.

Fig. 581.



Barrel-Header.

Bar'rel-head Hold'er. (*Coopering.*) A clamp consisting of a pair of jaws for holding barrel-heads in position while being trimmed around the edges.

Bar'rel-hoop'ing Ma-chine'. (*Coopering.*) A machine for setting the hoops on a barrel. A circular ring has pendent drivers, and is reciprocated by a rack-bar and pinion. The assembled staves are placed in upright position, and the hoops driven thereon by the downward motion of the drivers.

Bar'rel-loom. (*Weaving.*) *a.* A loom in which a barrel, usually a square prism, receives the perforated cards which determine the figures. A *jacquard loom.*

b. One used for weaving figured fabrics; the rising and falling of the heddles which govern the warps being accomplished through the agency of pins on the revolving barrel.

Bar'rel-mak'ing Ma-chine'. (*Coopering.*) A machine or series of machines by which some principal part of the process of, or the series of processes in, making barrels is performed.

BROWN'S English Patent, 1825, embraces the following series of devices: —

1. A circular saw, with a bench and slide-rest, having an adjustable guide consisting of a flexible bar, which is bent to the curve desired for the edge of the stave. A piece of wood of proper dimensions is clamped to the slide-rest, which is advanced by hand along the guide and presented to the circular saw, which gives the proper curve to the edge of the stave.

2. An apparatus with cutters, attached to a revolving standard, by means of which the staves, secured by temporary hoops, are crozed.

3. An apparatus somewhat similar to the above, in which the straight pieces of wood for forming the heads are held together, cut to the circular figure required, and beveled.

4. A machine in which the cask, after having been assembled and headed up by hand in the usual way, is revolved, while a cutting tool is made to traverse along its exterior, forming a smooth surface.

The arrangement of the machinery at Glen's Falls, N. Y., consists of three machines: the first for cutting the staves to the required length, finishing the heads, and making the croze; the second jointing the staves in packs; the third forming the heads.

Bar'rel-or'gan. (*Music.*) An instrument in which the notes are sounded by means of pins or staples, arranged as to time and place on the surface of a cylinder which is rotated by hand. See HAND-ORGAN.

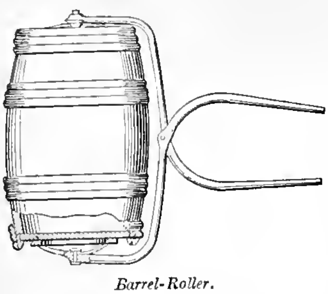
Bar'rel-pen. A steel pen which has a split cylindrical shank, adapting it to slip upon a round holder.

Bar'rel-pro'cess. A mode of extracting precious metals from ores. See AMALGAMATOR.

Bar'rel-roll'er. A device for clamping the ends of a barrel, and manipulating it so as to allow it to turn freely when rolled along on its bilge.

A pair of handles of a convenient size are crossed, and pivoted at the point of crossing like a pair of scissors. The opposite ends of the handles are each provided with a disk of a diameter somewhat less than that of the common barrel-head. Each disk is pivoted at its center to its supporting arm and so as to revolve freely. The handles are of such form that the disks may be applied, one at each end of a barrel, and pressed closely against it, whereupon the barrel may be easily rolled.

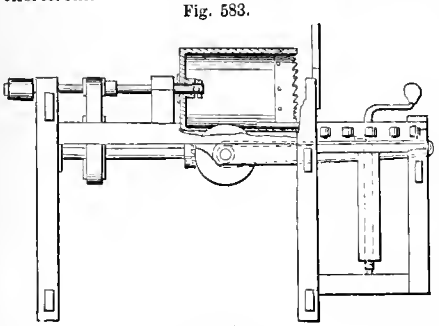
Fig 582.



Barrel-Roller.

Bar'rel-saw. (*Coopering.*) A cylindrical saw for sawing staves, etc., to a curved form They are afterward bent to the required longitudinal curve. The saw is mounted on a table, and means are provided for keeping it up to the work and retracting it therefrom.

Fig. 583.



Barrel-Saw.

Cylindrical saws are also used for sawing chair-backs, brush-backs, and fellies.

Bar'rel-screw. (*Shipwrighting.*) A form of screw-jack used in a shipwright's yard to move heavy timbers or assist in launching.

Bar'rel-set'ter. (*Gun-making.*) A cylindrical mandrel used by armorers for straightening the barrel of a fire-arm and in *truing* the bore or exterior surface.

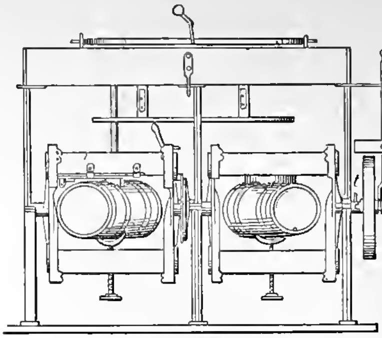
Bar'rel-vault (*Masonry.*) A cylindrical vault.

Bar'rel-vise. (*Gun-smithing.*) A bench-vise, having a longitudinal groove in its jaws to fit it for the reception of a gun-barrel, which may be protected from direct contact of the jaws of the vise by sheet-lead or other soft metal cheeks.

Bar'rel-wash'er. (*Brewing.*) A machine in which casks are cleansed after use, preparatory to refilling.

In one example, the barrels are clamped in the frames that turn on pivots in journals in an iron frame. The barrels are arranged at an angle to their line of rotation by a clamp with a corrugated surface that curves to suit the bilge of the barrel. To vary the angle to the plane of rotation of all the barrels simultaneously, the clasps are mounted in circular guide-ways on the clamping rails, so that they may vibrate in arcs of which the axis of rotation of the frame forms the center. This causes a swashing motion of the water endways of the barrel, by which its interior is cleansed.

Fig. 584.



Barrel-Washer.

Bar-ret-tees'. (*Fabric.*) A kind of plain silk.

Bar'rier. (*Fortification.*) An obstacle, such as a palisade or stockade, for defending an entrance to a fortification. It is provided with a central gate formed of strong upright timbers, connected by transverse beams at top and bottom and a diagonal brace.

Bar'rier-gate. (*Fortification.*) A gate closing the entrance through a stockade or barrier.

Bar'row. 1. (*Mining.*) A heap of *attle*, or rubbish.

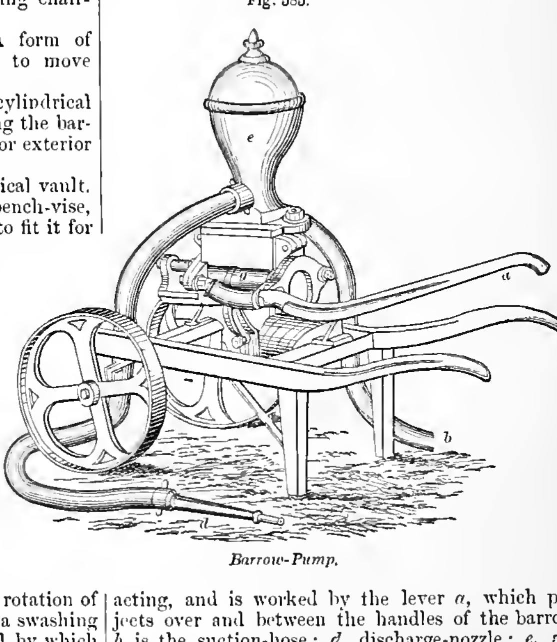
2. (*Vehicle.*) A light carriage for transporting articles, moved by hand. See HAND-BARROW and WHEELBARROW.

3. In salt-works, a wicker case in which the salt is put to drain.

Bar'row-pump. (*Hydraulics.*) A combined suction and force pump, rendered portable by being mounted on a two-wheeled barrow, and adapted for agricultural and fire-engine purposes.

In the illustration shown, the pump is double-acting, and is worked by the lever *a*, which projects over and between the handles of the barrow. *b* is the suction-hose; *d*, discharge-nozzle; *e*, air-chamber; *g*, cylinder.

Fig. 585.

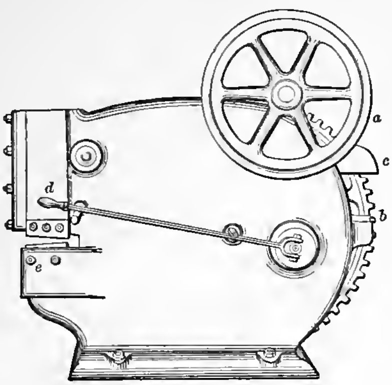


Barrow-Pump.

Bar-share Plow. (*Agriculture.*) One having a bar extending backward from the point of the share. Used in tending crops, laying out corn-rows, etc.

Bar-shear. (*Metal-working.*) A machine for cutting metallic bars. It consists of a very strong

Fig. 586.



Bar-Shear.

frame, having a fixed lower blade *c* and a vertically reciprocating upper blade *d*, between which the bar is sheared. *a* is the fly-wheel, *b* the main gear-wheel on the axis of the cam (hidden in the interior of the casing), which works the tail of the lever *c* and reciprocates the jaw *d*. See BAR-CUTTER.

Bar-shoe. (*Farriery.*) A horseshoe which is not open at the heel, but is continued round at the rear. It is used with horses which are liable to contraction of the heel, to spread that part of the foot.

Bar-shot. (*Ordnance.*) A projectile formerly used, consisting of two cannon-balls, or half-balls, united by a bar of iron, and employed for severing the rigging of vessels, as well as for field and fort artillery.

Shot used in proving ordnance may be considered as belonging to this class, consisting, as they do, of a bar with hemispherical ends, weighing twice or three times that of the solid shot used in service.

Bar-ti-zan'. (*Fortification.*) The overhanging turrets of a battlement.

Bar'ut-ine. (*Fabric.*) A kind of Persian silk.

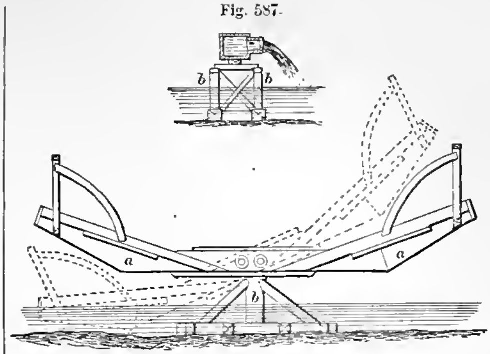
Ba-salt'ing. A process for utilizing the scoriæ of blast-furnaces for making paving and building blocks.

Ba-sane'. (*Leather.*) French tanned sheep-skins for bookbinding. *Bawsin.*

Bas'cule. (Fr. *see-saw.*) A form of bailing-scoop used by Perronet at the Bridge of Orleans was worked by 20 men, 10 at each end. 600 motions were given to it per hour, and at each motion 4 cubic feet of water were raised 3 feet high; 2,400 cubic feet per hour.

It consists of a pair of scoops *a a* on a single frame, which is pivoted to oscillate upon bearings on the summit of posts *b*, secured to a frame planted on the bottom of the river, pond, or inclosure to be drained. See BAILING-SCOOP.

Fig. 587.

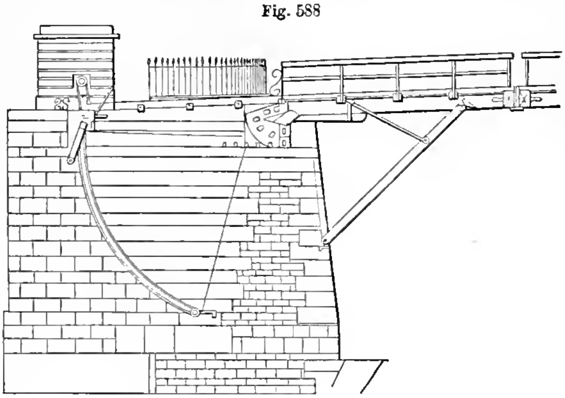


Perronet's Bascule.

Bas'cule Bridge. A counterpoise drawbridge which oscillates in a vertical plane; the inner portion descends into a pit, while the outer ascends and closes the gateway.

A bridge which has its truck simply hinged to the edge of the scarp or curbing, and which is lifted by weight or windlass, is classed as a LIFTING-BRIDGE (which see). The *bascule* has an inner portion of roadway, which acts as a counterpoise to the portion which projects over the water-way. The inner portion descends into a dry well when the bridge is

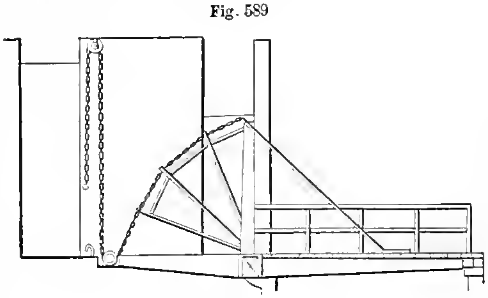
Fig. 588



Bascule at Brussels.

lifted into a vertical position, the outer portion closing the opening in the wall outside of the portcullis, if there be one. This form of bridge was not uncommon in the castles of the feudal times, when the rich owned the poor, and learning had no refuge but in the Church.

Fig. 589



Bascule Neuf Brisack.

A *bascule bridge* at Brussels, called a *balancing-bridge*, has an overweighed land end, so that it assumes the vertical when a chock beneath its inner end is removed. The land end works in a quadrantal pit lined with iron. The strut that supports the land end is footed upon a set-off in the masonry, and a swinging strut limits the depression of the bridge at its outer end. When tilted, the bridge is held in position by a rack and pinion.

Instead of the heavily counter-weighted platform, a pendent weight, chain, and pulleys may act upon a vertical arm to raise and lower the platform, which oscillates upon a horizontal axis.

Base. 1. (*Ordnance.*) The protuberant rear portion of a gun, between the *knob* of the *cascabel* and the *base-ring.*

The *base* is the middle member of the *cascabel* when the piece has a base-ring and knob. In the simplicity of modern pieces, many mere ornaments and extraneous matters are omitted. The *base* is always present, forming the rounded contour at the rear of the breech.

2. (*Carpentry.*) The skirting-board next to the floor of a room.

3. (*Surveying.*) The main line of a survey, ascertained by actual measurement, upon which the subsequent trigonometrical operations are founded.

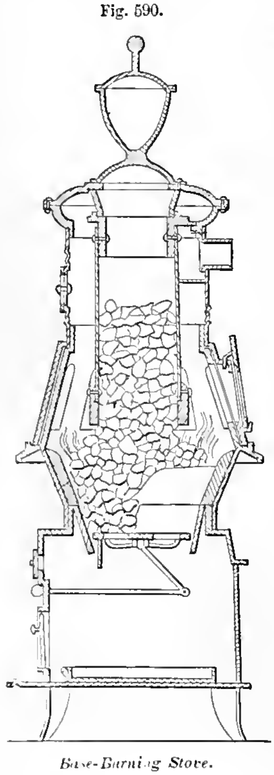
4. (*Architecture.*) The lower part of a structure: of a building it may constitute a basement; of a column it may consist of *base-moldings* and *plinth.*

5. (*Fortification.*) The line connecting the salient angles of two bastions.

6. (*Dentistry.*) A foundation resting immediately upon the gums, on or into which the artificial teeth are placed.

Base-burn'ing Fur'nace. A furnace or stove in which the fuel is contained in a hopper or chamber, from which it is fed to the fire as the lower stratum burns. The supply is thus continuous, the hopper holding a supply for any given time, according to its capacity.

Fig. 590.



Base-Burning Stove.

The idea seems to have originated in the "Constant Furnace" of the alchemists. See ATHANOR.

James Watt contrived a smoke-consuming furnace on that principle. See SMOKE-CONSUMING FURNACE.

The principle of the base-burner is also found in the furnace exhibited in 1685 by M. Delasme, at the fair of St. Germain. It consisted of a long tube like an inverted siphon, the longest leg of which formed the chimney and the shortest the furnace. The fuel was deposited on a grating near the top of the shortest leg, being supplied from above. Soon after ignition of the fuel, heat was communicated to the longest leg or chimney, and by that means a current of air was caused to pass downward through the fuel and under the grate, where the smoke was consumed.

Base-burn'ing Stove. One having a magazine to hold a supply of fuel, which falls out at the bottom as that in the fire-pot becomes consumed. In the example, the grate is arranged to be dumped without opening the base of the stove, thus preventing the escape of dust. The reservoir is constructed in three sections. Above the mica windows is a register for the purpose of admitting air to the fire.

Base'ment. (*Architecture.*) The lower story or floor of a building; the story of a house below, or partly below, the level of the ground.

Base-plate. (*Machinery.*) The bottom plate, to which the frame of an engine or machine is fastened. A *bed-plate.*

Base-ring. (*Ordnance.*) A molding on the *breech* of a gun, between the *base* and the *first reinforce.* See CANNON.

Base-vi'ol. (*Music.*) An instrument of the violin kind, the largest of the class. It has four strings and eight stops, divided by semi-stops. It is played by a bow.

Bas'il. 1. (*Cutting-tools.*) The ground surface of a cutting-tool which forms an angle with the back; as of a chisel, graver, plane-bit, etc.

The broad-axe, adz, firmer and paring chisels, gouge, plane-bit, graver, have but a single *basil:* one face is permanent and straight; the sharpening is done upon the *basil.*

Chopping-axes, hatchets, machetes, stone-axes, bill-hooks, swords, tomahawks, turning-chisels, etc., have a double basil, if it may be so termed. They are sharpened equally on the two faces.

2. (*Leather.*) A sheep-skin tanned with bark, and of quality for making slippers.

Bas'i-lisk. (*Ordnance.*) An old name for a long 48-pounder cannon; so called from the snakes which superseded the dolphins common on other guns.

Ba'sin. 1. (*Optics.*) The disk on an optician's stake, in which convex lenses are ground.

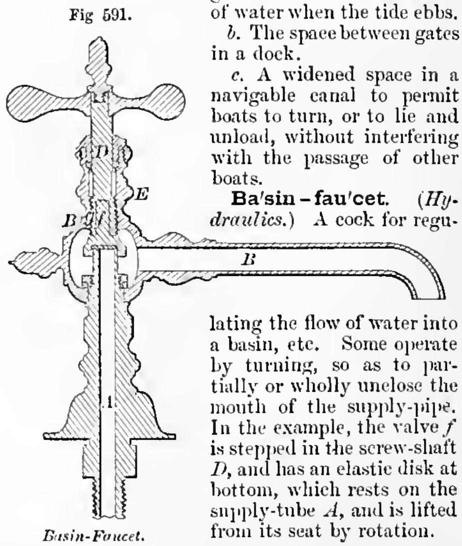
2. (*Hat-making.*) The iron mold in which a felt hat is formed.

3. (*Hydraulic Engineering.*) *a.* A wet-dock with gates to restrain the reflux of water when the tide ebbs.

b. The space between gates in a dock.

c. A widened space in a navigable canal to permit boats to turn, or to lie and unload, without interfering with the passage of other boats.

Fig 591.



Basin-Faucet.

Ba'sin-fau'cet. (*Hydraulics.*) A cock for regulating the flow of water into a basin, etc. Some operate by turning, so as to partially or wholly unclose the mouth of the supply-pipe. In the example, the valve *f* is stepped in the screw-shaft *D*, and has an elastic disk at bottom, which rests on the supply-tube *A*, and is lifted from its seat by rotation.

Other faucets operate by vertical pressure on a button or lever, which depresses a spring-valve and opens the water-way; the pressure being relieved, the efflux ceases.

Bas'ket. 1. A vessel made of flexible materials lapped or interwoven. The art of interweaving wands, leaves, and splints is of great antiquity. The ark of Moses was a basket of interwoven bulrushes, made water-tight by slime and pitch (Ex. ii. 3), 1571 B. C. The chief baker of Pharaoh dreamed that he had three white baskets upon his head filled with bake-meats, which probably meant cakes. This was 1717 B. C. (Gen. xl. 17.)

The ordinary use of the basket in gathering in the crop is indicated by the blessing of basket and store. (Deut. xxviii. 5.)

On opening one of the ancient tombs of Egypt, a lady's work-basket was found, containing the following articles, which may now be viewed by generations from twenty-five to thirty centuries subsequent to the time of the lady who used them. They are in the Abbott collection, New York City.

Two skeins of thread;
A small white *glass* bottle;
An ointment-box;
A toilet-box to contain kohl, for blacking the edges of the eyelids, as in the days of Jezebel;
A wooden netting-needle, charged with the original thread;
Two bronze needles;
One blade of a pair of scissors;
A piece of linen, partly darned;
Some bronze pins;
An ivory dress comb;
A wooden comb;
Four small ivory pegs, use uncertain;
A bronze spatula, for spreading unguents;
Some false hair, plaited.

Baskets from ancient Egypt, preserved in the Abbott Museum of Antiquities, New York City, are made of grass, reeds covered with leather, and of date-tree fiber.

Pliny refers to the suppleness and graceful slenderness of the osier willow, as fitting it for the weaving of baskets and many utensils employed in agriculture.

In ancient Egypt, wicker-work baskets were made of osiers and the stalks of the palm-leaf. They were made with and without handles, for various purposes, and of different sizes and shapes. Grain was sown from a basket; eggs, figs, and grapes are represented in baskets in the field and the store-room.

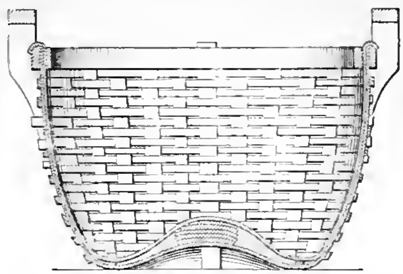
Baskets made of palm-leaves are preserved in the British Museum.

The ancient Britons excelled in making baskets, which were largely exported and sold for high prices at Rome. British articles were transported to Rome in baskets, and the British name for these hampers was there retained, — *bascuda*. The Welsh preserve it as *basgawd*. When Britain was first known to the Romans, the natives made boats of basket-work covered with hides, and boats made in a similar way are still used in parts of Wales. See CORACLE. Boats of split bamboo, woven like basket-work, are used in Hindostan, and in some parts of South America rush baskets capable of holding water are made by the natives.

A two-horse carriage of basket-work, termed a "Holstein wagon," is used in some parts of Europe, and this material is very commonly employed in the United States for the bodies of sleighs, and sometimes for pony phaetons. Rattan is, however, the neater and more desirable material.

For the finer kinds of baskets particularly, osier is the material most commonly used, but for a coarser basket, strips of split hickory, oak, or black ash, are frequently employed. Osiers are prepared for the basket-maker by being split asunder or stripped of their bark, according to the kind of work for which they are intended. Previous to being stripped, they require to be soaked in water, and the stripping is performed by drawing the willows through iron *brakes*, which remove the bark; they are next cleaned by a sharp knife, and exposed to the sun and air. The barked or white osiers are assorted into bundles or fagots according to size, the larger ones being used for the strong work in the skeleton of the basket, and the smaller for the bottom and sides.

Fig. 592.



Splint Basket.

When the osiers are used for ordinary work, they are taken whole; but for fine work, they are divided by an instrument consisting of two edge-tools set at right angles to each other, which quarter the rod longitudinally through the pith. These are next drawn through an implement resembling an ordinary spoke-shave, keeping the outer part of the split next to the wood while the pith is presented to the iron edge of the instrument; the split is further reduced and made regular in thickness by being drawn through a flat piece of steel having one cutting edge like a chisel; the flat is bent round so that the plain and cutting edges are made to approach or recede by means of set screws, regulating the thickness of the osier.

In basket-making, a number of rows are laid crosswise to form the start for the bottom, and are woven together by a spiral weft of wands, which pass alternately over and under the radial wands, to which others are added as the size increases; the wands are bent up to form the sides, and other rods are woven in and out between each of them, until the basket is raised to the intended hight. The edge or brim is

Fig. 593.

Basket-Making.

finished by turning down the projecting ends of the ribs, whereby the whole is firmly and compactly united. Handles are formed by forcing two or three osiers, sharpened at their ends and cut to the proper length, down the weaving of the sides close together, and they are pinned fast about two inches from the brim, so as to retain the handle in the proper position. The osiers are then bound or plaited, and the handle is finished.

Of late years much ingenuity has been exercised in devising forms of baskets for the carriage of fruit to market in packages of size proportioned to the character of the fruit. Osiers, splints, veneers, and paper have been employed. Some of these baskets are made frustum-shaped, so as to pack in nests for return; others have been made folding or collapsible; others of such cheap material and workmanship as to be sold with the fruit.

Veneer baskets are made with bails or handles, or simply as boxes. The parts are sometimes interwoven, but more often fastened by tacks or rivets.

2. (*Fortification.*) In field-works, a *gabion* or *corbeille* filled with earth and built into a parapet.

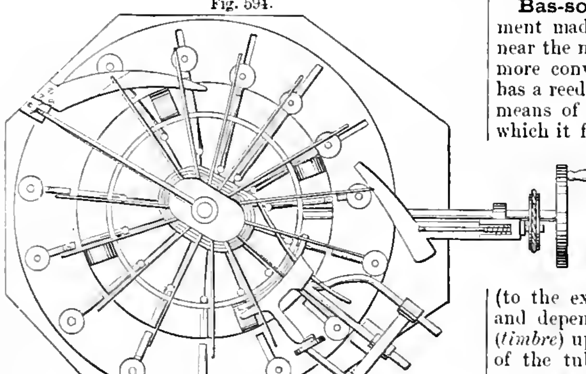
3. (*Hat-making.*) A wicker-work or wire screen of an oval shape, which collects the filaments of hair as they are lightly thrown on to it by the *bow*, which separates them from the bunch deposited on the bench. See Bowing.

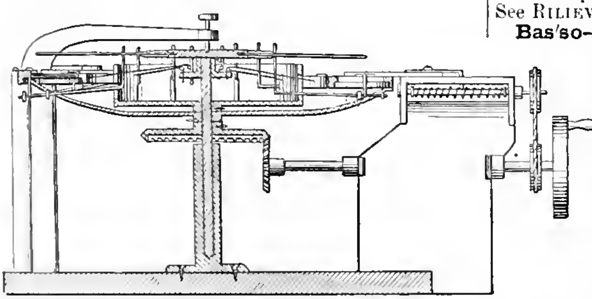
Bas'ket-car'riage. (*Vehicles.*) A small vehicle with a wicker bed, and adapted to be drawn by ponies.

Bas'ket-grate. A fire-grate for burning coal, in which the bottom and one or more of the sides are made of bars, with intervening openings through which air is admitted and heat emitted.

Bas'ket-mak'ing Ma-chine'. A circular wooden bottom-piece with radially projecting basket-strips is attached to the end of a rotating shaft, and during the rotation of the bottom and radial strips, a filling-carrying device having a vibratory motion passes over and under the radial strips, and leaves the filling carried by it, and this filling is laid in compactly by reed-like pieces. See patents for this class of machinery to F. H. Brown, Nos. 68,965, 69,309, 70,072, 70,160, 70,318.

Fig. 594.





Basket-making Machine.

In the example, the skeleton of a top or bottom is clamped to the shaft by set screws. The end of the filling is fed through the apron. Motion is applied to the driving-shaft which rotates the skeleton. The pad of the apron is vibrated by the action of the eccentric wheel that rests upon the ring, causing the rods to vibrate alternately above and below the filling, which is introduced between them.

Bas'ket-work. (*Fortification.*) Work involving the interweaving of withes and stakes. Such as *wicker-work, randing, wattling, waling-gabions, fascines, hurdles*, etc.

Ba'son. (*Hat-making.*) A triangular metallic plate upon which a covering of fur is laid and felted to make a conical napping, or *pull-over* for a hat-body. The same as Basin.

Bas'set. (*Mining Engineering.*) The *outcrop* or emergence of a stratum or seam at the surface.

Bas'set-horn. (*Music.*) A wind instrument resembling the clarinet in tone and manipulation, but larger. It is seldom employed in the orchestra, except in the execution of a few special pieces. It is believed to have been invented at Papan, about 1770, and afterwards perfected by Lotz, of Presburg.

Bas-sette'. (*Music.*) A small bass-viol.

Bass-horn. (*Music.*) A wind instrument of deeper tone than the bassoon.

Bas-soon'. (*Music.*) *a.* A musical wind instrument made of wood, and capable of being divided near the middle, so that the two parts may be of a more convenient length for carriage. The bassoon has a reed and curved mouth-piece, and is played by means of keys and finger-holes like the clarinet, to which it forms the bass. Its compass is three octaves, from double A in the bass, to A in the second space of the treble, and its designation generally is the F or bass clef, yet in the higher passages, for the more convenient arrangement of the notes, the alto or tenor clef is often used.

b. A reed-pipe stop in an organ, tuned (to the extent of its compass) with *open* diapason, and depending for the peculiar quality of its tone (*timbre*) upon the particular shape and proportions of the tube through which the vibrations of the tongue are emitted. See Stop.

Bass-re-lief'. (*Sculpture.*) Strictly speaking, *low relief*, but frequently used in a somewhat general sense to indicate the prominence of sculpture from the plane surface to which it remains attached. See Rilievo.

Bas'so-ri'li-e'vo. (*Sculpture.*) The slight projection of a sculptured object from the plane surface, as in the case of the figures on medals, coins, friezes, etc.; called, also, *low-relief*. See Rilievo.

Bass-vi'ol. (*Music.*) A stringed musical instrument resembling a violin, but larger, and having a graver tone. It is held in an upright position when played, the butt-end resting on the floor or some object but little elevated above it. The instrument now generally known as the bass-viol is, in fact, the violoncello.

Bast. A rope or cord made of the bark of the lime-tree, bass-wood, or linden; also the bark made into ropes and mats.

Bas'tard File. One of a grade between the *rough* and the *smooth*, in respect of the relative prominence and coarseness of the teeth.

The order is as follows: —

Rough.	Second-cut.
Middle-cut.	Smooth.
Bastard.	Dead-smooth.

The angle of the chisel in cutting the bastard file is about 10° from the perpendicular.

The number of cuts to the inch varies with the length of the file in inches.

Inches . .	4	6	8	12	16	20
Cuts . . .	76	64	56	48	44	34

Bas'tard Stuc'co. The finishing coat of plastering when prepared for paint.

Bas'tard Type. (*Printing.*) Type with a face larger or smaller than that usual to a body of given size; as, bourgeois on a brevier body.

Bas'tard Wheel. A flat bevel-wheel, or one which is a near approach to a spur-wheel.

Bas-ter'na. (*Vehicle.*) The *basterna* of the Romans was a litter or species of sedan, carried by two mules, differing from the *lectica* in that the latter was borne by slaves. The name is derived from a people of the Carpathian Mountains, and was afterwards applied to a species of ox-cart or wagon used by the early kings of France.

The name survives in a modern European carriage.

Bast'ing-ma-chine'. A sewing-machine making the *running* stitch, and used in *basting* together the ends of pieces of cotton cloth, in order to form them into a continuous length for convenient feeding and handling during the operations of *washing, bleaching, singeing, printing, dyeing*, etc.

Bas'tion. (*Fortification.*) A projecting portion of the main inclosure of a fortification, consisting of two faces and two flanks, sometimes single or *detached*, but usually arranged on the angles of the fortification, and connected by a retired part called a *curtain*. In field-works, a series of bastions, formed at the angles of a square or pentagon, and thus connected with an exterior ditch, and sometimes a glacis, frequently comprise the whole system of defence; but in fortifications of a permanent character these are surrounded by outworks, and the number of bastions may be increased indefinitely, the polygon forming the basis of the works being adapted to the shape and capacity of the place to be defended.

Fig. 595 is a plan of two bastions (*M L*) connected by a curtain with outworks, as arranged on the modern system.

The various parts not particularly described here may be found under their respective alphabetical heads.

A. Interior slope.
T. Terreplein of rampart.
R. Parapet of rampart.
A T R. Rampart.
a. Scarp.
M. Full bastion.
L. Empty bastion.
p q. Face of bastion.
q G. Flank of bastion.
K o p q G. Outline of bastion.
G H. Curtain.
t. Ramps.
B. Ditch.
D. Tenaille.
Y. Caponniere.
e. Batardeau.
F F F. Ravelin.
S. Redoubt in ravelin.
b. Counterscarp.
n. Traverses in covered way.
C. Reëntering places of arms.
W. Redoubt in places of arms.
P. Salient places of arms.
V. Covered way.
X. Glacis.

A *hollow* bastion is one in which the *terreplein* is not continued to the rear beyond a certain distance, at which a farther descent occurs.

A *full* bastion incloses ground which is even with the rampart.

An *empty* bastion has a *terreplein* adjacent to the parapet, and the middle portion is much lower.

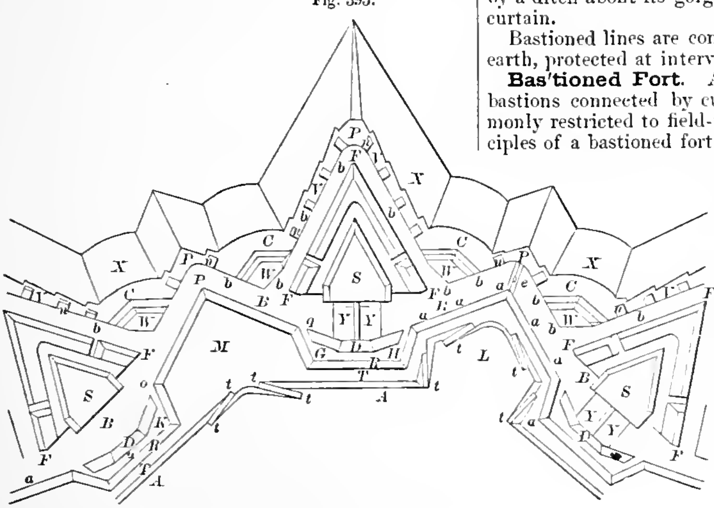
A bastion is said to be *composed* when two sides of the interior polygon are very unequal.

A *detached* bastion is separated from the inclosure by a ditch about its gorge, and not connected by a curtain.

Bastioned lines are composed of long parapets of earth, protected at intervals by bastions. See LINE.

Bas'tioned Fort. A fort having two or more bastions connected by curtains. The term is commonly restricted to field-works. The essential principles of a bastioned fort are, that it is constructed so that the most prominent part of each salient is on a line bisecting the angle of a polygon; the *flanks* are arranged perpendicularly to the face of the opposite bastions, so as to obtain a raking fire within easy musket-range.

Fig. 595.



Bastion.

Bat. 1. A mallet.

2. A club for striking a ball in various plays; as, base-ball, cricket, croquet, etc.

3. A rammer used by founders.

4. (*Fiber.*) *a*. Clean cot-

ton in loose and evenly spread condition. The product of the batting-machine, in which the cotton is *scutched*, *blown*, and delivered in an even continuous wad, which, when wound on a roller or axis, forms a *lap* and is ready for *carding*.

b. A scutching or beating sword for hemp or flax.

5. (*Plumbing.*) A plumber's tool, made of beech, about eighteen inches long, and used for dressing and flatting sheet-lead.

6. (*Hat-making.*) *a.* One or more slivers of carded wool, or a body of blown fur. The subsequent processes are *shrinking* and *hardening*; the first by immersion in hot water, the latter by pressure and rubbing. Felting succeeds.

Web, *lap*, *sheet*, and *sliver* are synonymes in this connection.

b. In hand-work, a bat may be said to be a light assemblage of felting-hair gathered by the bow. It is compacted by pressure of the hands on a piece of leather called the *hardening-skin*, and by rubbing.

7. A half or other portion of a brick large enough to be worked into a wall.

Bat'ar-da'te. (*Nautical.*) A square-stemmed rowing-galley.

Bat'ar-deau'. 1. (*Fortification.*) A wall across the ditch to retain the water in that part of a ditch requiring to be inundated. Its crest is too narrow to afford a passage for the enemy.

2. (*Engineering.*) A coffer-dam, or case of piling without a bottom, for building the piers of a bridge. See COFFER-DAM.

Bat-bolt. (*Machinery.*) A bolt barbed or jagged at its *butt* or *tang*, to retain it within an object cast or solidified about it.

Batch. A lot of prepared materials or articles, suitable in quantity for once charging a pot, furnace, or oven.

1. (*Glass.*) The *frit* of a glass-maker compounded and sifted for use, ready for the *glass-pot* or crucible.

2. A lot of dough or unbaked loaves.

3. (*Mining.*) A certain quantity of ore sent from a mine to the surface by a couple of men.

Bate. (*Leather.*) The alkaline solution employed in the preparation of hides, after liming and before tanning, to remove or neutralize the lime. See BATING.

Ba-teau'. (*Nautical.*) *a.* A flat-bottom boat, used in navigation and propelled by oars or by poles.

b. A *ponton* of a floating bridge.

Bath. 1. A vessel in which the whole or a part of the person may be washed or bathed.

2. A house or place where such conveniences are provided.

3. A tank containing a liquid for galvanic or electro-metallurgic purposes.

4. A vessel containing a fluid metal or heated composition, as a lead-bath or sand-bath.

Baths were long used in Oriental countries, and traveled by the route of Egypt to Greece. Homer mentions the use of the bath as an old custom. From Greece they reached Rome, imported, as it is said, by Agrippa. The thermæ (*hot baths*) were very splendid, and adorned for a people who spent much leisure among the baths and their voluptuous accessories. The marble group of Laocoön was found in 1506 in the Baths of Titus, erected about A. D. 80; and the Farnese Hercules in the Baths of Caracalla, erected A. D. 217.

A rollicking Greek thus writes:—

"And lately baths, too, have been introduced, — things which formerly men would not have permitted to exist inside a city. And Antiphanes points out their injurious character: —

'Plague take the bath! just see the plight
In which the thing has left me;
It seems t' have boil'd me up, and quite
Of strength and nerve bereft me.
Don't touch me! Curst was he who taught a
Man to soak in boiling water!'
Athenæus. Epit. B. I. 32"

Homer, however, mentions another set, who

"to the polished marble bath repair,
Anoint with fresh perfumes their flowing hair,
And seek the banquet hall."
Iliad.

At one period there are said to have been more than 800 of these establishments in Rome, many of them doubtless of the smaller class, founded by private individuals. The erection of baths was one of the principal means by which many of the emperors endeavored to obtain fame and popularity. Nearly all these structures have yielded to the ravages of time, but sufficient remains are left to afford an idea of their general construction and arrangement.

The Baths of Caracalla were probably the most magnificent structure that adorned the ancient capital of the world; they occupied a quadrangle of 1,011 by 1,080 feet. The entrance was decorated by a portico composed of two stories of arcades, one above the other, erected upon half-columns, Ionic below and Doric above. Some of the finest statues of antiquity have been found within these ruins, giving an idea of their original magnificence.

These, like other structures of the kind erected by the Romans, were heated by stoves, and had arrangements for affording three different kinds of baths, cold, tepid, and warm, according to the taste or requirements of the bather.

For a piece of money equivalent to about half a cent any Roman citizen could procure the advantages of one of these baths, which were accessible alike to the rich and the poor.

The buildings were illuminated at night by lamps and candelabræ, the light of which was, according to Seneca, thrown on crystal balls placed in the vaulting or on the walls, so as to produce the most dazzling reflection. Glass was introduced in the time of Pliny, who calls it *a modern invention*. He was mistaken.

Remains of baths have been found in all countries where the Roman power extended. At Chester, England, among the ruins of a bath were found bricks stamped with the impression LEG XX, leading to the inference that the structure had been erected by the 20th Roman legion, surnamed the Victorious.

Those of Pompeii are still in a wonderful state of preservation.

In one of the baths of Rome, the basin was found to be coated with a cement so hard that it was impossible to dissolve it sufficiently to analyze its substance. It was a Roman palm (about three inches) thick, and capable of resisting not alone the heat of the water, but the action of any heat whatever.

The Roman bath had six principal apartments:—

1. The Apodyterium, appropriated to undressing, had shelves all round, on which to place the clothes, and had attendants to take charge of them.

2. The Frigidarium, or cold bath.

3. The Tepidarium, situated between the Frigidarium and the warm bath, and having a medium temperature.

4. The Caldarium, heated by the *dry* heat of a stove; the Laconicum. Here the bathers sweated.

5. The Balneum, or warm bath.

6. The Eleothesium; an apartment heated by the Hypocaustum, or underground furnace. Here the oils and perfumes were applied.

A *douche* bath is one in which the water is driven or dropped forcibly upon the person or the part affected.

An *earth* bath is one in which the patient is covered with warm sand.

The names of other baths are sufficiently descriptive without detailed description under this general head.

Air-bath.	Shower-bath.
Electro-galvanic bath.	Sitz-bath.
Medicated bath.	Steam-bath.
Mercurial bath.	Turkish bath.
Russian bath.	Vapor-bath.

(*Photography.*) A solution in which plates or papers are immersed or floated; or the vessel holding said solution. Baths are known as *sensitizing* (the nitrate of silver bath), *fixing*, *toning*, or *washing*. They are of various forms, horizontal or vertical; the materials are glass, porcelain, or hard rubber.

Bath-brick. A fine silicious material, found in the vicinity of Bath, England, compacted into the form of bricks, and used as an abradant.

Bath-chair. (*Vehicle.*) A small hand-carriage with a hood. So called from the city of Bath, England, whose mineral waters are much frequented by invalids, and where the vehicle seems to have originated. For the legends of Bath, see Pickwick and the History of Prince Bladud.

Bath-fur'nace. A furnace for heating the water supplied to a bath.

Bath-heat'er. An apparatus for heating the water in a bath. It may consist of a pipe which connects with the upper and lower parts of the bathing-tub, and has a middle coil which traverses a furnace.

Bath'ing-ma-chine'. A portable room on wheels, for the convenience of bathers. It is run down into the water, so that the person is not exposed on the beach between the untiring-room and the water.

Bath'ing-tub. A tub or tank for bathing purposes; usually of elongated form, to permit the bather to assume a recumbent posture. The sitz or hip bath is like a deep-seated chair, and the water covers the person from the waist to the knees.

Bath-met'al. A brass for cheap jewelry, composed of, brass, 32; zinc, 9.

Bath-note. A folded writing-paper, 8½ by 14 inches.

Ba-thom'e-ter. (*Nautical.*) A measurer of depth. A *sounding apparatus.* The devices consist —

1. Of the common deep-sea lead and line.
2. Of devices for detaching the sinker on reaching bottom, enabling an attached tube to be drawn up separately, so as to secure a specimen from the bottom.
3. Of a weight within which a line is coiled to avoid friction in descending.
4. Of a sphere or spheres containing mercury, which the pressure at great depths forces into a tube or gage graduated so as to record the depth attained.
5. Of a spiral vane actuating a train of clock-work which registers the number of revolutions made by the vane, and thus indicates the depth. See SOUNDING APPARATUS.

Bath-stone. (*Masonry.*) An English building-stone of the oölitic formation.

Bat'ing. (*Leather Manufacture.*) The operation of steeping hides and skins in an alkaline solution consisting of the dung of chickens, pigeons, dogs, etc.

In this they remain six or eight days, according to the temperature of the *bate* and the thickness of the hide.

The *bating* follows the *liming* or unhairing solution, and the object of the former is to neutralize the lime and render the leather pliable.

Dog's dung (*album Græcum*) was formerly and is still applied; the ammonia probably being the active agent.

Sheep-skins are bated in bran-water.

The bating forms a chemical combination with the lime, the ammoniacal chloride parting with its chlorine to form the chloride of lime, which is readily dissolved in water.

MACBRIDE, in 1774, showed the property possessed by hydrochloric acid of dissolving the lime in the manner accomplished by the *bate*.

TURNBULL used sugar in the proportion of four or five pounds of cane-sugar or molasses to seventy gallons of water. This formed a soluble saccharate of lime.

WARRINGTON, 1841, employed carbonate of ammonia.

Ba-tiste'. (*Fabric.*) *a.* A very fine, white, thick linen cloth or cambric. Made of a fine quality of white flax grown in the South of France, and called *ramé.* (Not the *ramie.*)

b. An East India goods of similar quality.

Bat-print'ing. (*Porcelain.*) One mode of *porcelain printing;* the other is termed PRESS-PRINTING (which see). The former is printed on *glazed ware*, the latter on the *biscuit.*

In *bat-printing* the lines of the engraving are fine, and the impression is taken in linseed-oil on a thin slab of gelatine cut to the size. The oil having been transferred to the glazed ware by pressing the gelatine against it, is next dusted with the metallic color by means of cotton-wool. The color is melted and fixed in an *enamel-kiln.*

Bat's-wing Burn'er. (*Gas.*) A form of gas-burner in which gas issues at a slit so proportioned as to give to the flame the shape of a bat's wing.

Batt. The hat-maker's term for the basis of the *skin*, or bowed materials of a hat. *Bat.*

Bat'ten. A strip of wood or a scantling, as may be required, for various purposes.

1. (*Carpentry.*) *a.* A cleat or bar nailed transversely on a structure of jointed planks, such as a door or shutter, to prevent warping and preserve the relative position of the parts.

A *batten* door is formed of planks laid side by side, and secured together by slats fastened across them, without exterior framing.

b. A board 2 to 7 inches wide, and from ⅝ to 2 inches thick. (English practice.)

c. In *furring*, scantling secured to brick walls to form a foundation on which plastering lath is laid.

d. A strip nailed to the rafters, to which slats are nailed.

2. (*Plastering.*) A batten is placed at exposed corners so as to be flush with the worked surface of plaster, and resist abrasion or blows. Called also an *angle-staff.*

3. (*Cotton.*) A web or bat of fibers.

4. (*Weaving.*) The beam which forces up the weft. *Lay* or *lathe.*

5. (*Nautical.*) *a.* One of the strips placed around the hatches, to keep down the tarpaulin which covers them.

b. Strips tied around standing rigging to keep it from chafing.

Bat'ter. 1. (*Engineering.*) The backward slope of a wall, to enable it to withstand an outward thrust, as of a bank which it retains. *Retaining* and *breast walls batter* towards the bank. See BREAST-WALL.

2. (*Forging.*) To spread metal outwardly by hammering on the end. The impact upsets the bar or rod, and extends it outwardly.

3. (*Pottery.*) A plaster mallet used to flatten out a lump of clay which is to be laid and formed upon the *whirling-table.*

The batting is done upon a *batting-block* of wet plaster.

Bat'ter-ing-gun. (*Ordnance.*) One of heavy caliber, specifically adapted for demolishing works. Examples: the 18 and 24 pounder smooth-bore, and the 4½-inch rifled gun of the United States service.

Bat'ter-ing-ram. An implement, used before the invention of gunpowder, for making breaches in the walls of fortified places. It consisted of a long pole or beam, with an iron head, suspended between uprights. The head sometimes weighed a ton or more. The men who operated it were protected by the *testudo*, a movable shed with a curved roof, adapted to resist the stones, etc., thrown on it by the besieged.

This machine is incorrectly stated to have been invented by Artemon, a Lacedemonian. It was employed by Pericles, about 441 B. C. The pole was from 80 to 120 feet long, and suspended by cords on which it oscillated, being retracted by the united efforts of a number of men, who pulled the cords and then allowed the spar to swing forward and bring its armed head against the masonry of the besieged fortress. Its effects were sought to be avoided by lowering down bags which acted as fenders to deaden the blow, by burning the framework, or by hurling missiles at the operators. See descriptions of Roman military engines, and Josephus.

Assyrian antiquities upset the Greek claim of first invention. Battering-rams are shown in the sculptures of Nimroud. The machine is worked from within, upsetting the walls by dislodging the stones. The *testudo* was made of wicker-work, and ran upon six wheels.

The battering-ram is mentioned by the prophet Ezekiel (iv. 2 and xxi. 22) about 590 B. C.

Bat'ter-ing Plumb-rule. (*Engineering.*) An instrument for leveling sloping work. The sides are cut to the required angle with the central line, over which the plummet hangs.

Bat'ter-ing-rule. (*Engineering.*) A rule or templet by which the *batter* or slope of a *retaining* or *breast* wall is regulated in building.

Bat'ter-ing-train. (*Ordnance.*) A train of heavy ordnance for siege operations.

Bat'ter-lev'el. (*Engineering.*) An instrument for measuring the angle of a slope. See CLINOMETER.

Bat'ter-y. A number of objects or devices in position; as of *guns, plates, kettles*, etc.

A position or place in which objects are mounted; as a *sunken, barbette*, or *casemate* battery.

Barbette battery.	Grove battery.
Battery forge.	Gun battery.
Battery gun.	Half-sunken battery.
Breeching battery.	Hat-maker's battery.
Bunsen battery.	Leclanche battery.
Callaud battery.	Leyden battery.
Carbon battery.	Magneto-electric battery.
Casemate battery.	Masked battery.
Covered battery.	Mountain battery.
Cross-fire battery.	Open battery.
Daniell's battery.	Ricochet battery.
Double-fluid battery.	Siege battery.
Electric battery.	Single-fluid battery.
Electro-magnetic battery.	Smee battery.
Elevated battery.	Stamp battery.
En-echarpe battery.	Submarine battery.
Enfilading battery.	Sugar-kettle battery.
En-revers battery.	Sunken battery.
Field battery.	Thermo-electric battery.
Floating battery.	Voltaic battery.
Galvanic battery.	

Many of these are described under their alphabetical heads.

1. (*Fortification.*) *a. Barbette battery;* the guns are elevated to fire over the top of the parapet, and not through embrasures.

b. Breeching battery; one employed in making a practicable breach in an enemy's works.

c. Blinded battery; one masked or hidden till the time comes to make it effective.

d. Casemated battery; one firing through embrasures in a bomb-proof chamber.

e. Cavalier battery; one mounted on an elevated interior work.

f. Counter battery; one on the crest of the glacis, to cover the storming party.

g. Direct battery; one firing perpendicularly upon a work.

h. Enfilading battery; one which flanks a work, entrenched line, or line of attack.

i. Fixed battery; one permanently established, as in a fortress.

j. Floating battery; one on a raft or ship.

k. Inclined battery; one on a sloping ground.

l. Indented battery; one with indentations or occasional notches which command the face.

m. Joint battery; one of two which form supports to each other.

n. Leveled battery; one in which the interior has the natural level, the parapet being gained by earth from the ditch.

o. Masked battery; one artificially concealed.

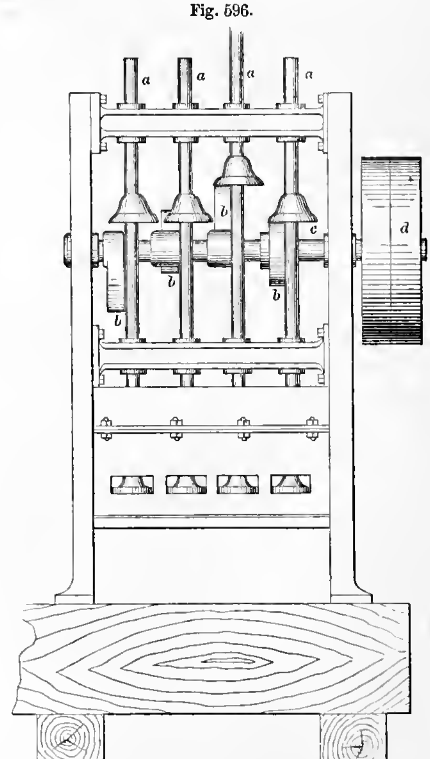
p. Oblique battery; one to deliver an enfilading fire.

q. Open battery; one of field artillery.

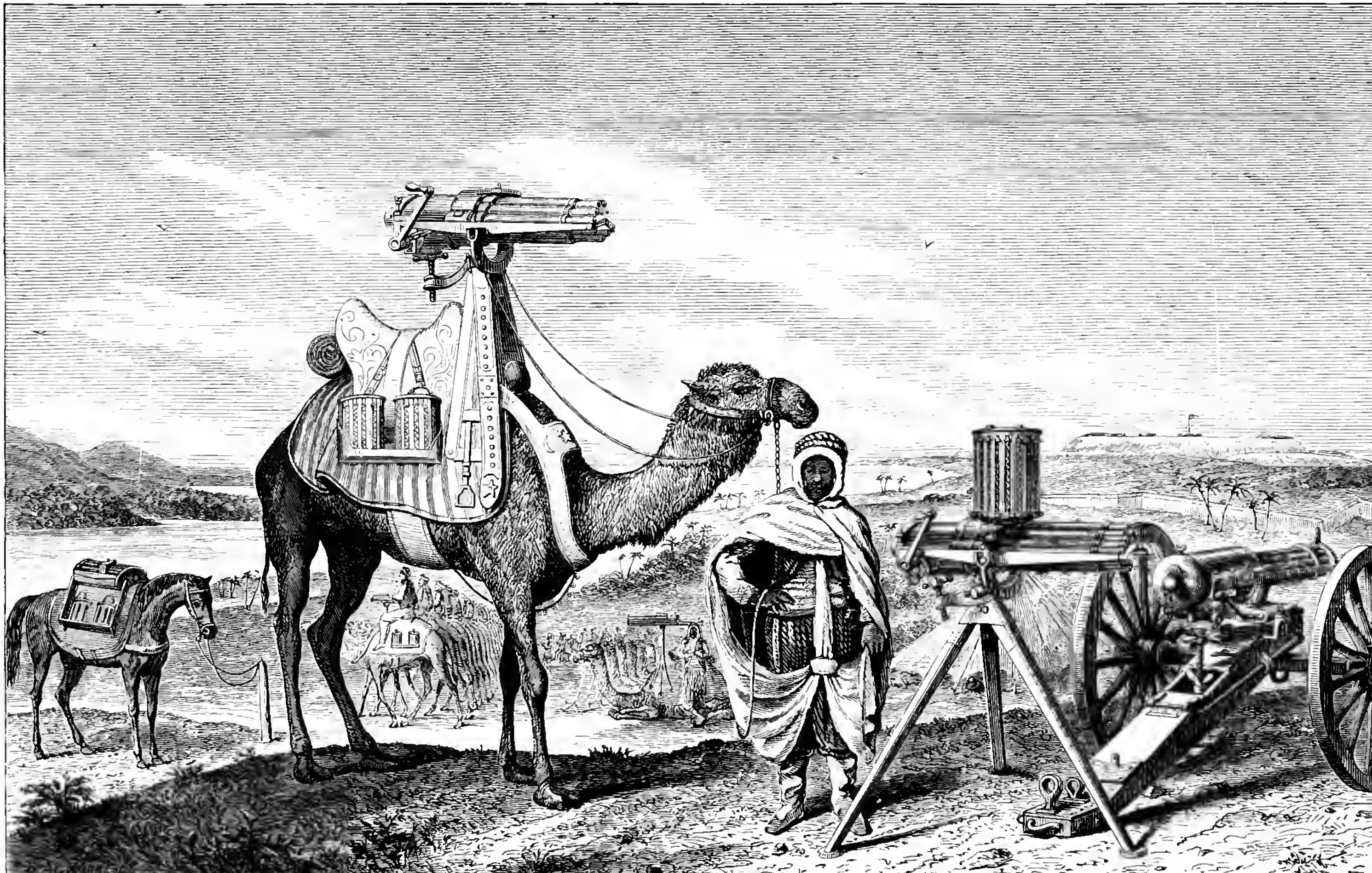
r. Ricochet battery; one delivering its fire with small charges, the missile rolling and popping along the ground.

s. Sunken battery; the included space of which is excavated.

Fig. 596.



Stamp Battery.



GATLING'S BATTERY-GUN.

PLATE VI.

EGYPTIAN SERVICE.

See page 249

2. (*Metallurgy.*) A series of *stamps* operated by one motive power, for crushing ores containing the precious metals.

The stamps *a* (four in the series shown) are raised consecutively by the cams *b* on the shaft *c*, to which motion is imparted by a belt on the pulley *d*.

3. A number of connected Leyden jars, adapted for coincident charging and discharging. See ELECTRIC BATTERY.

4. An apparatus for generating galvanic electricity. See GALVANIC BATTERY.

5. A vessel with sides protected to withstand cannon projectiles, and pierced for heavy guns. Distinguished from an ordinary war vessel by its comparatively imperfect capacity for navigating in all waters and weathers. A floating battery.

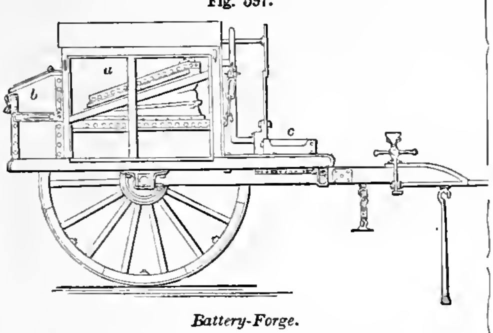
6. (*Nautical.*) The guns mounted on each deck of a ship of war; as the *main-deck*, *lower-deck*, and *spar-deck* batteries.

Bat'ter-y-brush. A small brush, shaped like a hair-brush, used for cleaning or brushing off oxides formed on zinc, and for evenly distributing the mercury or amalgam over the zinc.

Bat'ter-y Com'mu-ta'tor. (*Telegraphy.*) An apparatus by which the strength of a current may be altered, so that one third, two thirds, or the whole of the elements may be brought into service by changing the place of a contact-peg. See Sabine, p. 104.

Bat'ter-y-forge. A traveling forge which accompanies a field battery. The body is constructed like that of a caisson, except that in place of the two ammunition-chests it has a *bellows-house a*. This

Fig. 597.



Battery-Forge.

contains the bellows, and has a space partitioned off for iron and steel. In the rear is a box *b*, to hold 250 pounds of bituminous coal, and in front is the fireplace *c*, upon which the anvil is placed in traveling. An upright plate of strong sheet-iron is interposed between the fireplace and the front of the bellows-house. In the limber-chest are contained a set of blacksmith's and farrier's tools packed in four boxes (for field batteries). In the United States service battery-forges are divided into two classes, A and B. One of the former accompanies each field battery, and contains a forge as well as the blacksmith's and farrier's tools, iron and steel, horseshoes, and spare parts necessary for making the more ordinary repairs to the iron-work of the battery.

Forge B, which is precisely alike in size and construction, contains nearly the same tools and stores as forge A, but has, in addition, certain articles and spare parts which are less likely to become broken or worn out in service. It remains in the rear with the field and siege train.

Bat'ter-y-gun. A gun having a capacity for firing a number of shots consecutively or simultaneously, without stopping to reload. There are a number of varieties.

1. A piece of ordnance having a number of load-chambers attached to a vertical axis, and consecutively presented at the rear of a cannon-bore. As each takes its place at the breech, it is advanced into the bore and locked before firing. (HARDY, 1862; DODGE, 1856.)

2. A chambered breech-piece, revolving in a vertical plane, and presenting its chambers consecutively at the open rear of the barrel, which is common to all the chambers. The principle of construction is that of the revolving chambered pistol. (HEDRICK, 1870.) See also FIRE-ARMS, where PUCKLE'S Revolving Battery Gun, English Patent, 1718, is described and figured.

3. A number of parallel barrels arranged in rank, and having connected vents for intercommunication of fire. (TOWNSEND, 1871.) The infernal machine of Fieschi, which he fired on Louis Philippe, was a row of barrels clinched to a frame, and had a train of powder which was laid over all the vents in succession, like the row of barrels in a proving-house.

The Requa battery consists of 25 rifles, each 24 inches long, mounted in a horizontal plane upon a field-carriage. It is breech-loading, the cartridges being forced into the chambers by a sliding bar worked by two levers. By a lever beneath the frame the barrels may be diverged, so as to scatter the balls 120 yards in a distance of 1,000 yards.

The weight of the battery-gun used at Charleston, S. C., was 1,382 pounds. Served by three men, it fired 7 volleys, or 175 shots, per minute. Its effective range was 1,300 yards.

4. Forms of many-barreled cannon, revolving on a vertical axis, the pieces being muzzle-loaded. (MILBURN, 1866. Divergent, NATCHER, 1864.)

5. A cluster of rotating barrels, consecutively loaded and fired by automatic action. (GATLING, 1861–65.) This will have a longer description presently.

6. A cluster of barrels, in whose rear is placed a chambered plate, each of whose chambers corresponds to one of the cluster of barrels, against whose rear it is locked before firing. The MITRAILLEUR (which see).

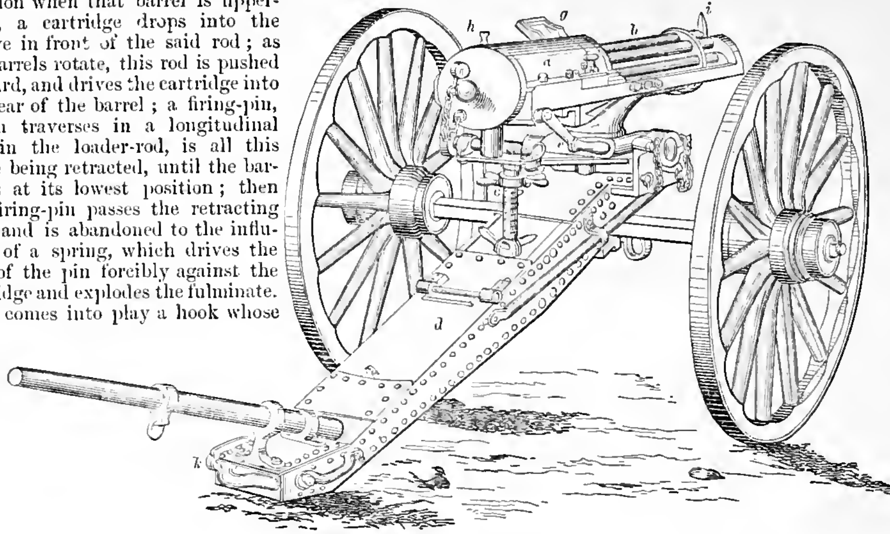
7. A number of chambered blocks brought consecutively to the positions for loading, and then for firing, through a group of barrels equal in number to the number of chambers. (TAYLOR, 1871.)

The Gatling gun has a revolving cluster of parallel barrels. In the rear of each barrel, and rotating therewith, is its own loading, firing, and spent-cartridge-shell-retracting mechanism. All these parts are rigidly secured upon an axial shaft, which is revolved by means of bevel gearing and a crank, as shown in Fig. 598, and also in Fig. 599, which are respectively rear and front views of the gun mounted. In the rear of the cluster of barrels *b* is a stationary cylinder *a*, within which are the loading plungers, the firing-pin, and the cartridge-retractor.

Each of these parts moves horizontally and in line with the barrel to which it appertains, the motion being attained by the pressure of lugs on the moving mechanism against stationary cam-rings in the cylinder as the cluster of parts revolves. The ammunition is fed in at the hopper *g*; or, as in an improved form shown in the full-page engraving opposite to page 250, the ammunition is contained in a feed-drum which is placed above the hopper, and delivers its cartridges one at a time from its successive rows. Its capacity is four hundred cartridges, and these may all be fired in one minute.

As the cluster of barrels revolves, the operative mechanism in the rear of each barrel comes under the influence of the cam-rings in the interior of the cylinder. The loading-rod of a given barrel being in the most retracted position when that barrel is uppermost, a cartridge drops into the groove in front of the said rod; as the barrels rotate, this rod is pushed forward, and drives the cartridge into the rear of the barrel; a firing-pin, which traverses in a longitudinal slot in the loader-rod, is all this while being retracted, until the barrel is at its lowest position; then the firing-pin passes the retracting cam, and is abandoned to the influence of a spring, which drives the end of the pin forcibly against the cartridge and explodes the fulminate. Now comes into play a hook whose

Fig. 598.

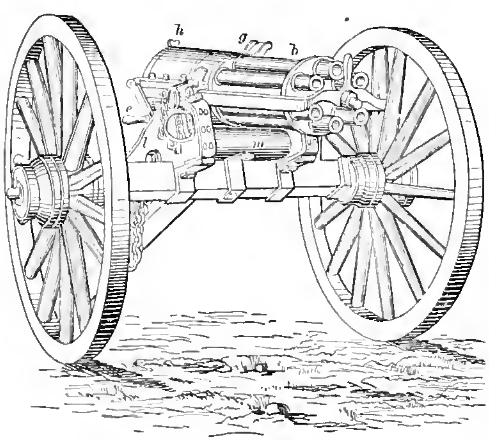


Gatling Gun (Rear View).

shank runs parallel with the loader-rod, and withdraws the empty shell of the cartridge, which drops out of the machine. The barrel then takes its turn again above, and so the work proceeds.

e is the working-crank, *c* the elevating-screw, *d* the trail, *k* the loop by which the trail is attached to the limber, *h i* are the back and front sights, *l* the cheeks of the carriage. In the view on the opposite page the Gatling gun is represented as adapted to various services: mounted on tripod, on carriage, on horse, on camel. The weight of the guns is 125, 300, 500, 600 pounds, according to size. The firing is always one shot at a time, and a number of shots

Fig. 599.



Gatling Gun (Front View.)

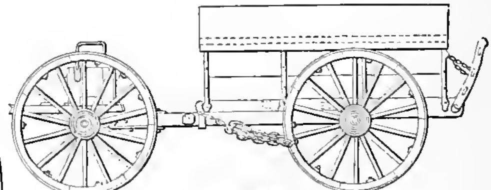
equal to the number of barrels at each revolution of the crank. The recoil is practically nothing. Arrangement is made for horizontal adjustment to deliver a sweeping fire.

Bat'ter-y-head. (*Railroad Engineering.*) The end of an embankment under formation, over which the contents of the gravel-wagons are dumped.

Bat'ter-y-wag'on. A four-wheeled vehicle, expressly adapted for the purpose of transporting the tools and spare parts required for the repairs of a battery of artillery in the field; one is attached to each battery.

It has a body 98.8 inches long and 3 feet wide in the clear, and an arched wooden top, turning over on hinges like a trunk-lid. At its rear is a rack for forage. The wagon-body and the limber-chests carry

Fig. 600.



Battery-Wagon.

spare parts for the carriages, harness, etc.; also harness-maker's tools, paint, oil, candles, axes, hatchets, picks, and miscellaneous tools.

In the United States service battery-wagons are designated, according to their contents, C and D. The former accompanies the field-battery in its evolutions, and is posted a short distance in the rear in time of action. It contains the tools, materials, and spare parts necessary to repair on the spot the smaller casualties most likely to occur to the wood-work and harness of the battery.

Battery-wagon D is precisely similar in construction, but contains a different set of stores and tools, such as armorer's tools and laboratory implements, as well as such spare parts of gun-carriages as are less likely to require replacement.

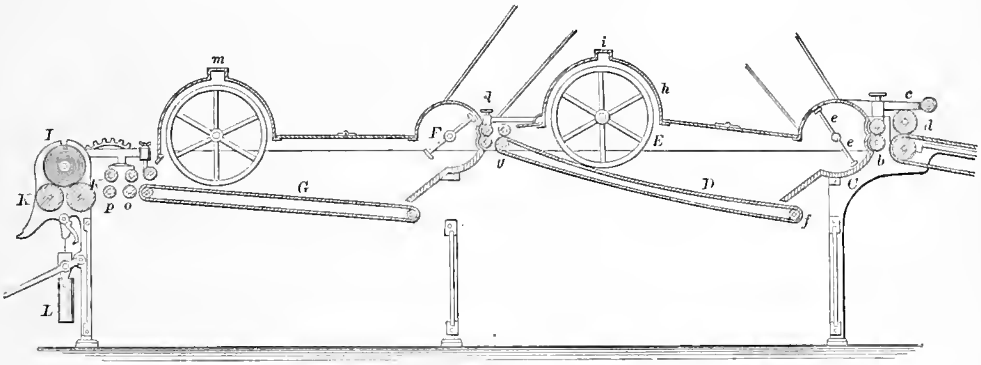
It remains with the vehicles of the field-train, and is only resorted to when the means afforded by wagon C are inadequate for the necessary repairs.

Bat'ting-block. (*Pottery.*) A block of wet plaster on which a dab of clay is flattened out by a *batter*, to prepare it for being placed on the *whirling-table*, where it is formed by a mold and templet into a piece of circular ware.

Bat'ting-ma-chine'. (*Fiber.*) A machine in which cotton partially loosened and cleaned by the *willowing-machine* (which see) is *scutched, blown*, and *lapped* so as to fit it for presentation in a soft, downy, and even wad to the carding-machine.

As a preliminary process, the cotton is carefully weighed, a given quantity being distributed on a certain surface of the slatted feed-apron, which has occasional black slats in order to mark certain areas. The cotton, being spread evenly over the given area, passes into the throat of the machine under the compressing-roller *d*, and then between the feed-rollers *b*, which are pressed together by a weight acting upon a lever *c*, which acts upon the brasses above the rollers. Passing the fluted cylinders *b*, the cotton is immediately exposed to the first scutching-beater, which consists of two flat bars *e e* fixed at right angles upon a revolving shaft, so as to strike upon the cotton as it issues from between the feed-rollers. The *scutcher* makes 2,000 revolutions per minute in near proximity to the grated concave *C*, through which dirt escapes. The cotton is wafted on to a traversing slatted apron *D*, which revolves on the rollers *f g*, passing beneath a revolving cage-cylinder *E*, inclosed by the cover *h*, in the top of which is a dust-duct *i*, in communication with a revolving fan, which exhausts the air from the interior

Fig 601



Batting-Machine.

of the machine, and therewith withdraws the dust. The reticulated cylinder *E* allows the air and dust to pass, but retains the cotton fiber, which is pressed into a *bat* upon the apron *D*, and delivered to a second pair of feed-rollers *l*, when it is again exposed to a scutcher *F*, which acts similarly to the one before described. This scutcher has 2,200 revolutions per minute, and delivers the cotton to an apron *G*, which carries it beneath another reticulated, dust-withdrawing cylinder in communication with the air-exhaust duct *m*.

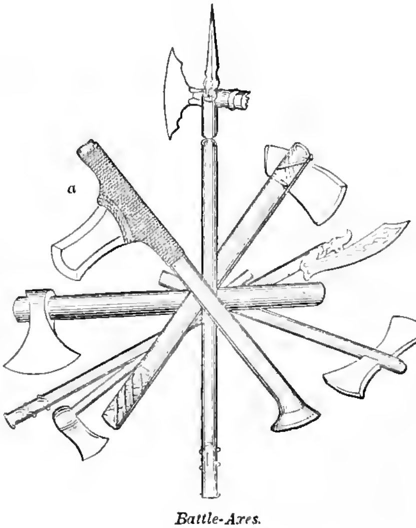
The cotton thence passes in a fleecy mass to the pressure-rollers *o p*, which deliver the compressed fleece to the cylinder whose axis is loaded by suspended weights *L*, which bear it down upon the carrying-rollers *K K*, whereby the fleece is condensed as it is wound. As the lap-cylinder *I* increases in diameter, the links rise, carrying the weights *L*, and when the *lap* has attained the required size, the main portion of the machine is thrown out of gear, while the twin rollers *p p* continue to revolve, and thus tear the bat apart in the middle between the pairs of rollers *o p*. The attendant then removes the lap, hooks up the weighting device, places another lap-cylinder in position, starts the machinery, restores the action of the weight, and guides the advanced edge of the bat around the cylinder. See COTTON-CLEANER.

Bat'ting-staff. An implement used by laundresses for beating linen in washing.

Bat'ti-tu'ra. The scales which fly off from metals while under the hammer.

Bat'tle-axe. This military weapon is of very remote antiquity, being made of stone before the discovery of metals. (See AXE.) It was used by the Sacæ, who formed a part of the forces of Xerxes.

Fig 602.



Battle-Axes.

Brennus, the Gallic king, who captured Rome, was armed with a battle-axe, and in remote ages it appears to have been considered peculiarly as the weapon of an uncivilized people. It was, however, extensively employed during the Middle Ages, and was in use as late as the sixteenth century, when attempts were made to improve it by attaching a pistol to the handle.

a, battle-axe from Dr. Abbott's collection of Egyptian antiquities in New York; made of bronze, firmly bound to its original handle by means of slender interlaced thongs of leather. It was found at Thebes.

The other figures represent battle-axes, more or less rude, of the times known as the "Roman period" and the "Middle Ages."

Bat'tle-dore. 1. (*Glass-making.*) A flat wooden paddle, used in flatting glass while still plastic, as in making the flat bottoms of decanters, etc.

2. An instrument of play, having a handle and a flat surface, or palm, formed of a hoop, and stretched parchment covers. It is used in playing shuttlecock.

Bat'tle-ment. (*Architecture.*) An open or interrupted parapet on the roof of a building. A parapet with embrasures.

Bauge. (*Fabric.*) A French fabric made with thread spun upon coarse wool.

Bav'in. A fagot of brushwood, sometimes used as a fascine.

Baw'sin. Leather made from sheep-skin. (Fr. *basane.*)

Bay. 1. (*Architecture.*) One of the lights or compartments between mullion and mullion in the great windows of the pointed style.

2. (*Carpentry.*) A portion of a compound or framed floor included between two girders, or a girder and the wall.

a. A case-bay is between two girders.

b. A *tail-bay* is formed of common joists, where one end of each is framed into a girder and the other rests on a wall.

c. A portion of a wall included between pilasters or buttresses, or of a ceiling between the beams of the panels.

3. The term is also used in a compound form: —

a. A *bay of plastering;* between two screeds which regulate the working of the float.

b. A *bay of roofing;* the small rafters and their supporting purlins between two principal rafters.

c. A *bay of joists;* the joists between two binding-joists, or between two girders in a framed floor.

Hay-bay in a barn; a *sick-bay* on shipboard.

4. (*Ship.*) That part on each side between decks of a man-of-war which lies forward of the butts.

5. (*Bridging.*) The portion between two piers.

6. (*Mining.*) The space between two frames in a gallery.

7. (*Hydraulic Engineering.*) *a.* The head of a lock.

b. A compartment containing water for a wheel, as a *fore-bay.*

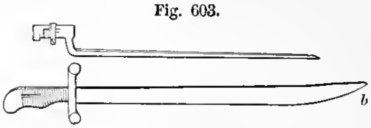
Bay-bolt. One with a barbed shank.

Bay'o-net. A piercing weapon, fixable on the muzzle-end of a fire-arm. They were originally made at Bayonne, in France, in the latter half of the seventeenth century, and used by that nation in the Netherlands in 1647. The weapon was introduced into the English army in 1672, and used at Killiecrankie, in Perthshire, where the forces of William of Orange, commanded by Mackay, were defeated by those of James II., under the command of Graham, of Claverhouse, 1689; and also at the battle of Marsaglia, 1693, "with great success against the enemy, unprepared for the encounter with so formidable a novelty."

The first known bayonet was a kind of long and slender rapier, with a wooden handle, or plug, which was inserted into the muzzle of the musket. Previous to this it had been customary to distribute musketeers among the pikemen, the two mutually supporting and assisting each other. The above-named arrangement for fixing the bayonet does not seem to have prevailed long, and was soon superseded by a slotted socket on the lower part of the bayonet, which slipped over the muzzle of the musket and was held in position by a stud on the barrel. The ring-bayonet was introduced in 1693, and the socket-bayonet in 1703. This form continued in use for about 150 years, an annular clasp and screw being added about 1842 in the United States service.

The "sword" bayonet *b* seems to be of very recent origin, having been first recognized in the United

Fig. 603.



Bayonets.

States army in 1856. Its utility as a weapon is very questionable. It is believed that this form of bayonet was first introduced in the French service among the Chasseurs de Vincennes, who used it in Algiers, in the Crimean campaign of 1854–55, and the Italian war of 1859.

It is secured to the rifle by a ring in the guard and a spring-catch in the hilt.

The *saw-bayonet*, having a sword edge and a saw back, is now being tested for the British arms. The *spade-bayonet* has also its advocates, it being intended to enable the soldier to intrench his position. The tendency seems to be to beat their spears into trowels and their swords into pruning-saws, but the peaceable intention is not apparent. See Intrenching Tools.

The bayonet-blade is forged under a trip-hammer, after which it is rolled to a proper form by sets of rollers adjusted to give it the required shape and taper. The socket is then forged, and the two portions welded together. It is next twice swaged by the "drop," then ground and polished; the former on a stone, and the latter on wheels bound with leather and covered with emery. The bayonet is rigidly gaged, and then tested by weight and by blow to determine its soundness and temper.

Bay'o-net-clasp. A movable ring of metal surrounding the socket of a bayonet, in order to strengthen the socket and render the bayonet less easily detachable.

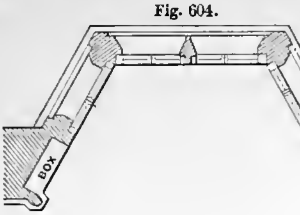
Bay'o-net-joint. A peculiar form of coupling, in which one circular piece, having a slot longitudinal for part of its length and transverse the remainder, is sleeved over another. The interior piece is provided with a stud which enters the slot, and, by turning, the two parts become locked so as to prevent withdrawal by a longitudinal movement.

Bay'o-net Scab'bard. The sheath in which the bayonet is placed. It has a loop at its upper part, called the *frog*, through which the waist-belt passes.

Bay-stall. (*Building.*) A fixed seat within a window-opening.

Bay-win'dow. (*Building.*) A *bow*-window; one projecting from the general surface of the house. It is usually of semi-polygonal shape, sometimes semicircular or semi-elliptical.

Fig. 604.



Bay-Window.

Bdel-lom'e-ter. A cupping-glass to which are attached an exhausting syringe and a scarificator.

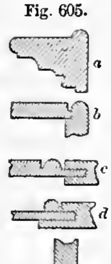
Bea'con. A structure erected for the purpose of assisting navigation by pointing out those dangers which, owing to the difficulty and expense that would attend the placing of more efficient marks to serve by night as well as by day, are necessarily left without lights, or which, from the peculiarity of their position in passages too intricate for navigation by night, are considered sufficiently indicated by day-marks alone. They are generally placed on rocks or banks only which are dry at some period of the tide. On rocks in exposed situations beacons are sometimes of squared masonry, firmly joggled together; but in situations difficult of access, and where an uncompleted structure of masonry could not be safely left exposed to the storms of winter, an open framework of iron, firmly trussed, braced, and secured to the rock, is preferable. In less exposed situations, where the bottom is of rock, gravel, or hard sand, a conical beacon, composed of iron plates and partially filled with concrete, is sometimes employed.

In a comprehensive sense, a lighthouse is a *beacon*: but the term technically refers to day marks, or to night marks where cressets are employed.

A *sonorific beacon*, so called, is one provided with an apparatus for sounding an alarm. See FOG-ALARM.

Bead. 1. (*Carpentry.*) A small salient molding of semicircular section.

Fig. 605.



Beads.

a. Cock-bead.
b. Quirk-bead.
c. Bead-butt.
d. Bead-flush.
e. Double-quirked bead.

A small globular ornament, often occurring in a long series, forming a band or molding.

The strip on a sash-frame which forms a guide for the sash. The *beads* are known as the *inside*, *outside*, and *parting beads*.

2. (*Bookbinding.*) A roll on the head-band of a book.

3. The proof of spirit, consisting in the appearance of the rising bubbles.

4. A perforated piece of glass, metal, or other material, adapted to be strung in a series, and used for the purpose of ornament or in devotion. This latter use came from Asia to Europe, and from the latter to America.

Glass beads originated with the Egyptians, — at least, such are the indications. One, in the possession of Captain Henvey, has a hieroglyphic inscription which shows its date to be about 1500 B. C. Glass bugles and beads for necklaces were much used by the Egyptians, and for a sort of network in the mummy-wrappings.

Beads strung in chaplets have long been in use for devotional purposes among Eastern nations, and are worn by the Chinese and Tartar Buddhists, as well as by the Turks and other Mohammedan nations. The Chinese rosary is composed of 108 beads of stones and coral, which are sometimes as large as pigeon's eggs. The use of beads in the Christian Church is of great antiquity. St. Augustine mentions them A. D. 366. Peter the Hermit had a series of 55 beads. Dominic de Guzman, A. D. 1202, introduced the rosary of 15 large and 150 small beads. Beads were used by the Druids in the time of Cæsar.

Beads are made of a great variety of materials: gold, diamond, amber, pearl, coral, jet, garnet, crystal, steel, paste, wood, glass, etc., much the greater proportion, however, being of the latter material. The manufacture is extensively carried on at different places in Europe, that of each place being characterized by some peculiarity in the style or manner of manufacture. Immense numbers are made at Birmingham, certain varieties of which are sold by thousands of dozens as dolls' eyes.

At Murano, near Venice, where great numbers are made, tubes of glass of various colors are drawn out to a great length and cut into very small pieces of uniform length, which are then put in a heap with a mixture of sand and wood ashes, and stirred with a spatula until the cavities become filled. The mixture is then transferred to an iron pan suspended over a moderate fire, and stirred until the cylindrical bits of glass assume a smooth rounded form. (See BEAD-FURNACE.) When removed from the fire, and their bores cleaned out, they constitute beads.

A very beautiful and costly sort of beads are made in imitation of pearls, from which the best qualities differ so slightly in appearance as to require an expert to detect the difference. The bead is blown into a thin bulb, and the pearly appearance produced by pouring into it a mixture of liquid ammonia mixed with the white matter from the scales of certain kinds of fish, as the bleak. The pearl matter is prepared by removing the scales from the lower part of the fish, washing them, and soaking them in water until the pearly film falls off and forms a sediment in the bottom of the vessel; this is dissolved in liquid ammonia and injected into the beads, so as to form a thin coating inside; after which the better kinds have melted white wax poured in, rendering them much more durable. Artificial pearls were invented by a Frenchman named Jaquin, in the time of Catherine de Medicis, and are principally manufactured in the department of the Seine, where great improvements have been made in the art; such as giving irregular forms to the large bulbs, to increase their resemblance to pearls, and exposing them for a short time to the vapor of hydrofluoric acid, so as to remove the glassy appearance of the exterior coating. Mucilage of gum-arabic is also used instead of wax, which increases the translucency, and is not liable to be melted by heat.

Beads of agate, carnelian, and allied stones are made in British India by breaking the stones into pieces of the required size, and chipping them with a hammer until rounded. They are then fixed in wooden clams, and partially polished by rubbing on a coarse, hard stone, after which they are similarly treated by being rubbed on a board covered with emery and lac. The polishing process is completed by placing a large number of them in a leathern bag partially filled with emery-dust and a fine powder derived from the stones themselves in drilling, and rolling the bag backwards and forwards for some ten or fifteen days by means of a thong passing around it and operated by two men seated at the opposite sides of a room. The holes are afterward drilled with a steel drill tipped with diamond dust.

Bead and Butt. (*Carpentry.*) Framing in which the panels are flush, having beads stuck or run upon the two edges. See *c*, Fig. 605.

Bead and Quirk. A bead stuck on the edge of a piece of stuff flush with its surface. See *b*, Fig. 605.

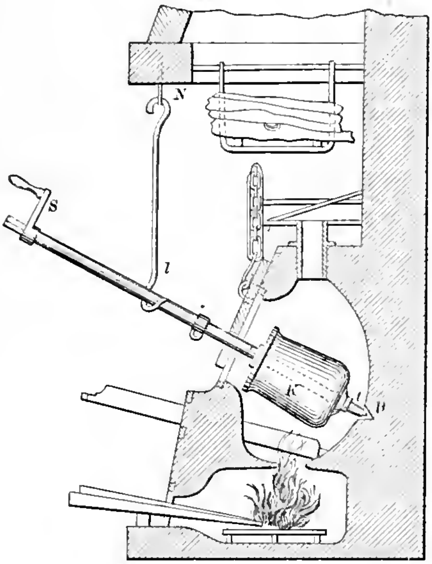
Bead-butt and Square-work. (*Carpentry.*) Framing with bead and butt on one side and square on the other; used in doors.

Bead'ed Wire. An ornamental wire having globular enlargements at regular intervals.

Bead'ed-work Lathe. See MILLED WORK; GAGE-LATHE.

Bead-fur'nace. (*Glass.*) A furnace in which glass beads are rounded after the cylinders have been cut to the proper lengths. The back of the furnace *B* has a step, into which the point of the axis *t* of the drum *K*, in which the beads are placed,

Fig. 606.



Bead-Furnace.

is inserted. This and the hook *l*, suspended from the upper projecting part *N*, serve as supports for the drum in its inclined position. The heat is maintained at a point sufficient to soften, but not to melt, the beads, and the rounded form is imparted to them by rotating the drum by means of the handle *S*.

Bead-loom. (*Weaving.*) A gauze-loom in which beads are strung upon the threads, the intersections of the threads being occupied by the beads.

Bead-plane. (*Carpentry.*) A molding-plane of a semi-cylindric contour, generally used in sticking a molding of the same name on the edge or on the side close to the arris. A set consists of nine planes, each working a half-round of given radius.

Bead-tool. (*Wood-turning.*) A tool for turning convex moldings. Its end has a semicircular or other curved form, with a sharp edge corresponding to the contour of the bead desired.

Beak. 1. (*Architecture.*) A small pendent fillet forming a channel behind, to prevent water from running down the lower bed of the cornice.

2. (*Shipwrighting.*) The rostrum or prow of a ship. Pisæus is said to have added it to the ancient galleys. It is now revived in the *ram*.

More technically speaking, a part of the ship before the forecastle, fastened to the stem and supported by the main knee.

3. (*Carpentry.*) The crooked end of the holdfast of a carpenter's bench.

4. (*Forging.*) *a.* The point of an anvil. The *horn*. The *beak-iron* or *bick-iron* is all beak.

b. A toe-clip or a horse's shoe turned up against the hoof.

5. (*Nautical.*) *a.* A ram, pike, or *rostrum* on the stem of a vessel to run down an opponent.

b. The part of a ship forward of the stem and supporting the figure-head.

6. (*Chemical.*) The rostrum of an alembic which conducts the vapor to the worm.

7. One of the jaws of a forceps or pliers, named after some real or fancied resemblance to the protruding facial organ; as, —

Hawk's-bill forceps.	*Round-nose* pliers.
Narrow-beak forceps.	*Crane's-bill* forceps.
Long-nose pliers.	*Crow's-bill* forceps.

8. (*Gas-Fitting.*) A gas-burner with one round, smooth hole $\frac{1}{28}$ of an inch in diameter.

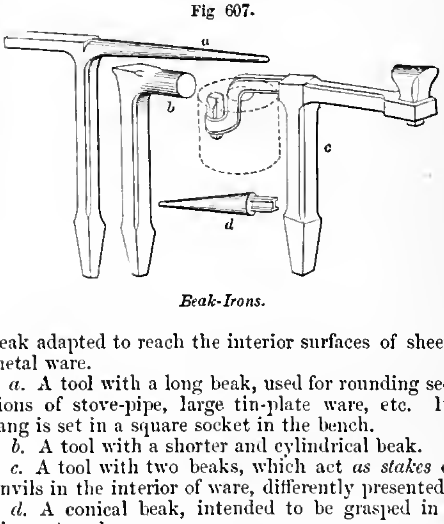
Beak'er. (*Glass.*) An open-mouthed thin glass vessel, having a projecting lip for pouring; used for containing solutions requiring heat, etc. *Beaker-glass.*

Beak'-head Beam. (*Shipbuilding.*) The longest beam in a ship.

Beak'ing-joint. The joint formed by the meeting of several heading-joints in one continued line, which is sometimes the case in floors and doors.

Beak'-i-ron. 1. (*Sheet-iron Working.*) *Beak, Beck, Bick-iron, Bickern.* An anvil with a long

Fig 607.



Beak-Irons.

beak adapted to reach the interior surfaces of sheet-metal ware.

a. A tool with a long beak, used for rounding sections of stove-pipe, large tin-plate ware, etc. Its tang is set in a square socket in the bench.

b. A tool with a shorter and cylindrical beak.

c. A tool with two beaks, which act *as stakes* or anvils in the interior of ware, differently presented.

d. A conical beak, intended to be grasped in a vise. A stake.

2. The horn of an anvil.

Beale-light. An argand burner, in which the flame is fed with air under pressure, rising through the central aperture. Named after its inventor.

Beam. A straight piece of wood or iron in the frame of a structure, usually occupying a relatively elevated, horizontal, and transverse position: as the *beams* of a ship that support the deck (uniting the sides above the keel, the *spine* of the vessel); the *beams* of a house or barn, stretching across it, and supported by the side walls or posts.

Relative size, character, position, and importance have caused the word to be applied to a long straight piece in a machine or tool, whether poised (*a*), journaled (*b*), or fixed (*c*).

a. The poised *beam* of a balance, to whose respective ends the scales are attached. In the Roman balance or steelyard, the *beam* is not radically equipoised, but one end is longer than the other, so that a smaller weight on one end shall counterbalance a larger on the other in calculated proportions, as in many counter scales and all platform scales. The larger descriptions of the latter have combinations of *beams* or levers.

b. The *working* or *walking beam* of a steam-engine, which is poised at its mid-length, and sustains at its respective ends the connecting-rod to the slide of the piston-rod, and the pitman which drives the crank of the paddle-wheel shaft. In the Cornish pumping-engine, in place of the pitman, is attached the pump-rod. This oscillating piece is usually called a *beam*, and such an engine is sometimes called a *beam-engine*. See also SIDE-BEAM ENGINE.

c. The straight, cylindrical, horizontal bars in a loom, on which the yarn and fabric are wound, called the *yarn-beam* and the *cloth-beam* respectively.

1. (*Building.*) Specific denominations have been conferred upon beams in framed structures of wood.

a. Tie-beam; one uniting the ends of a pair of principal rafters, or a pair of posts, to prevent spreading or divergence.

b. Collar-beam; a horizontal strut connecting and bracing two opposite rafters.

c. Dragon-beam; a piece of timber to receive and support the foot of the hip-rafter.

d. Straining-beam; one used in a truss or frame to confine principal parts in place.

e. Camber-beam; a horizontal beam in a simple span, whose sill has two posts, two struts, and a *camber-beam* uniting the tops of the posts.

A beam bent or built into an arched shape to support a *sill* or *summer*.

f. Hammer-beam; a tie-beam proceeding from the feet of a pair of principal rafters, but having its middle portion removed; the ends at the gap are stayed by ribs springing from corbels below, and support other ribs which spring into an arch.

g. Binding-beam; a tie-beam which binds together portions of a frame.

h. Girder-beam; a tie-beam.

i. Truss-beam; the principal horizontal timbers of a truss, called the *top* and *bottom chord*, and from which proceed the *stays* and *braces* which hold and push respectively, so to speak, and confer rigidity upon the frame.

j. Summer-beam; a central floor or ceiling timber, resting at its ends upon the walls or the girders of the exterior frame, and supporting the ends of the joints which are notched into it.

k. Arched beam; a beam bent, cut, or built into an arched form to support a structure. See ARCHED BEAM.

l. A *built-beam* is one made of several parts scarfed or strapped together.

m. A kerfed beam is one whose under side has a number of transverse kerfs penetrating to a certain depth, so as to enable the beam to be bent. See ARCHED BEAM.

n. Ground-beam; a sill for a frame.

o. The *box-beam* is a form of *girder* having a double *web*, inclosing a *box* or *cell*. (See GIRDER.) It is usually of iron. See Figs. 216, 218.

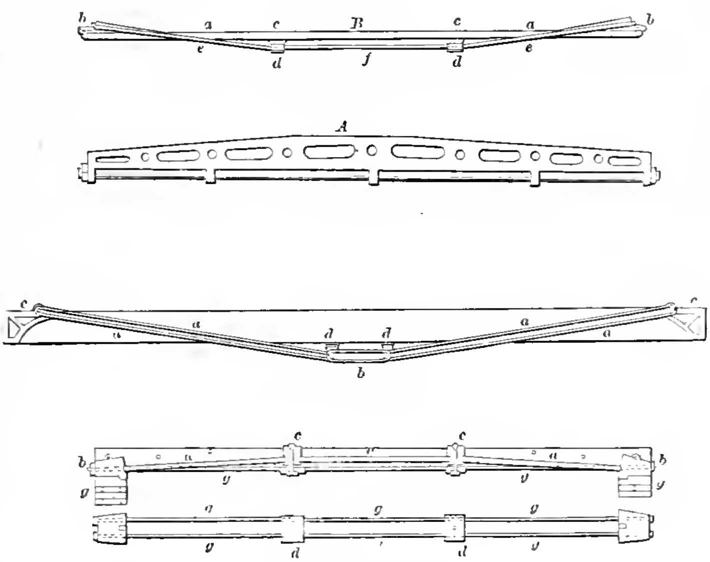
Fig. 608 represents four forms of beams in English use.

B represents a girder on the suspension principle, the wooden girder *a a* being stayed by the tension-rods *e e f*, which are looped over the cast-iron toe-plates *b b*. At points one third of their length from either end the rods are bolted to iron cross-pieces *d d*, which rest against blocks *c c* beneath the beam.

A is a cast-iron girder with a wrought-iron tie-bolt.

The next beam in the figure shows a pair of parallel girders with cast-iron foot-plates *c*, embracing the ends of each, holding them at their distance, and affording points of attachment for the suspension-rods *a a*, which are secured by screw-nuts to the iron saddle-pieces *d d*, the latter being connected by links *b*.

Fig. 608.



Beams.

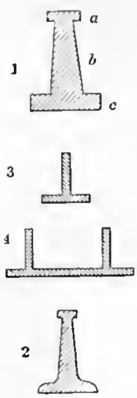
The lower illustration (Fig. 608) is a combined wood and iron girder, used to support a large brewery-vat, weighing, when full, about 100 tons.

The main features of this beam consist of three cast-iron plates *a a a*, whose abutting ends rest against cast-iron blocks *c c*, and which form a kind of arch, supported by a bow and string truss *g g d d*. The ends of the beams rest on shoes *b* and wall-plates *g*.

Mr. Hodgkinson, of England, is said to have determined the true shape of a cast-iron beam, as deduced from his discovery of the fact that the resistance of cast-iron to direct crushing is more than six times its resistance to tearing.

It consists (1, Fig. 609) of an upper flange *a*, web *b*, and lower flange *c*. The sectional area of the lower flange, which is subject to tension, is nearly six times that of the upper flange, which is subject to crushing. In order that the beam, when cast, may not be

Fig. 609.



Cast-Iron Beams. Sections.

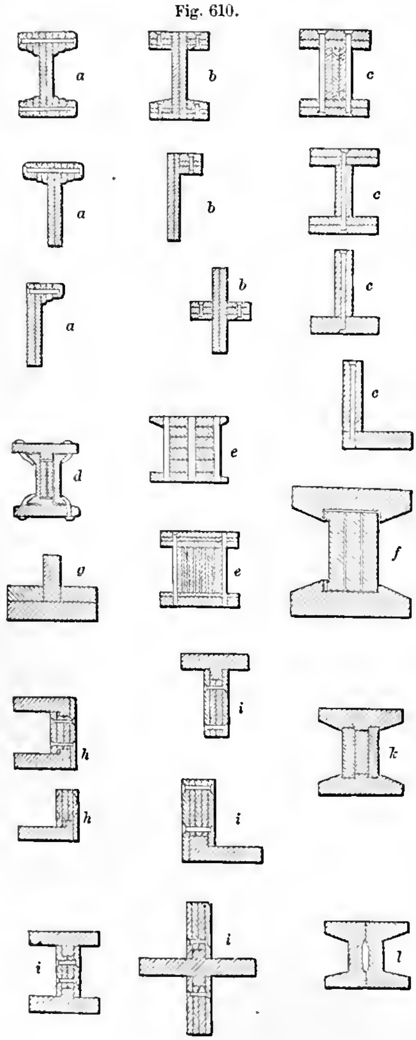
liable to crack from unequal cooling, the thicknesses of the vertical web at its upper and lower edges are nearly equal to those of the flanges at top and bottom respectively.

The most usual shapes of cast-iron beams are shown in the views, which present cross-sections.

1, 2. Double-T beams.
3. Inverted-T beam.
4. Trough-shaped beam.

Fig. 610 shows a number of forms of sections of fagots for wrought-iron beams, the webs and flanges being made up of plates riveted together, and so disposed as to bring the fibrous strength of the iron into the most advantageous positions. The fagots, having been made up, are heated in a furnace, and then rolled by a train whose "passes" have the appropriate size and shape to bring the beam, by successive operations, to the shape and size required in the finished beam.

Fig. 610.

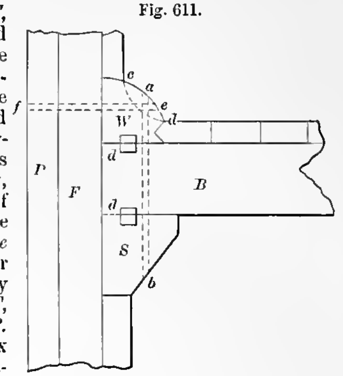


Fagots for Beams.

2. (*Shipbuilding.*) One of the curved transverse timbers of a vessel, supporting a deck.

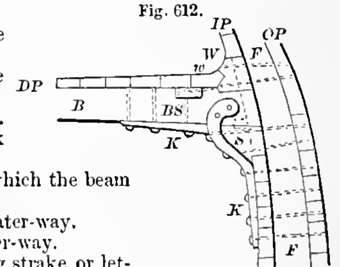
The end of the beam *B* rests on a shelf *S*, which is bolted through the futtocks *F*, and its upper and lower sides are secured by dowels *d d'* to the water-way *W* and shelf *S*. A vertical bolt *a b* ties the water-way, beam, and shelf together, while another bolt *f e* secures together the water-way *W*, futtock *F*, and planking *P*. *c d* is the convex curve of the water-way, for which may be substituted the concave curve shown in dotted lines. The *water-way* forms a tie above the beam and below the *spirketing*.

Fig. 611.



Beam.

Fig. 612.



Ship's Beam and Fastenings.

F, frame.
O P, outside planking.
I P, inside planking.
B, deck beam.
D P, deck planking.
S, shelf to which the beam end is coaked.
W, thick water-way.
w, thin water-way.
B S, binding strake or letting-down strake.
K, forked iron knee.
Dotted lines show the bolts.

A *midship-beam* is a ship's deck-beam about the waist.

An *orlop-beam*; a beam of the lower deck, or where one would be were it laid.

3. (*Nautical.*) *a.* A fender-beam is the inclined beam of an ice-breaker, shod with iron. A beam to protect a quay or jetty by receiving the impact of the vessels alongside.

b. The *shank* of an anchor from one of whose ends the *arms* diverge, and whose other end passes through the stock, or conversely.

c. The width of a vessel is called her breadth of beam.

4. (*Weaving.*) *a.* The roller on which the yarn is wound, and from which it is *let off* as the weaving progresses. The *yarn-beam*.

b. The roller on which the goods are wound by a *take-up* motion as the weaving progresses. The *cloth-beam*, or breast-beam.

5. (*Railroad Engineering.*) The *swing-beam* is a cross-piece supported by the frame of the truck, and sustaining the car-body in such manner that a certain lateral motion and play is allowed.

6. (*Currying, etc.*) The board over which a hide is placed to be *unhaired*, *struck*, or *shaved* by the knives adapted to those processes.

The *unhairing-beam* is a cylindrical table on which the hides from the lime-pit are placed while the hair is scraped off.

The *striking-beam* is a cylindrical horse on which the hides are occasionally scraped by a triangular steel knife, during the time they are drying after removal from the tanning-liquor.

The *currier's beam* is an inclined post over which the hide is stretched to be shaved by the currier's knife.

The currier's beam in a slanting position is shown in the ancient paintings of Kourna, Thebes.

7. *Swipe-beam;* the counterpoise lever of a draw-bridge.

8. The oscillating lever of a steam-engine. A working-beam or side-lever.

9. The main piece in the frame of a plow to which the handles, clevis, and standard are attached.

10. The straight working-edge of the stock of a square or bevel.

11. The bar on which slide the sockets carrying the points, pencil, or pen, of a *beam-compass.*

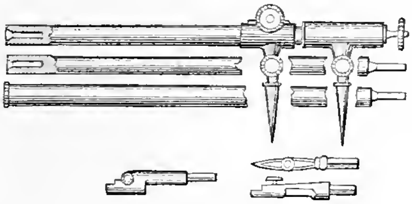
12. The *pole* or *tongue* of a carriage (*not much used*).

Beam-board. The platform of a steel-yard or balance.

Beam-cen'ter. (*Steam-Engine.*) The pin on which the working-beam vibrates.

Beam-com'pass. Sometimes called a *trammel.* An instrument for describing large circles. It has a *beam* or rod, and two sliding sockets which carry the steel point and the pencil or pen points. Set-screws on the sockets hold them to their places on the beam.

Fig 613.



Beam-Compass.

Beam-en'gine. (*Steam-Engine.*) An engine with an oscillating beam, to whose respective ends the connecting-rod from the piston and the pitman from the crank are attached.

In the Cornish engine the connecting-rod is at one end and the pump-rod at the other end.

To avoid the elevation of the working-beam, so common in our Atlantic and Eastern river steamers, the side-lever engine has been invented. This brings the engine into more compact form, throws the weight nearer to the keel, and places the engine below the water-line in some cases, — an especial advantage in war-vessels. See SIDE-BEAM ENGINE; MARINE STEAM-ENGINE; LEVER-ENGINE.

The old atmospheric engine of Newcomen was a beam-engine, and he is justly regarded as the inventor of the *working* or *walking beam.* (See STEAM-ENGINE; ATMOSPHERIC-ENGINE.) The pump-rod and the piston were suspended by flexible connections from arcs on the ends of the working-beam. When Watt came to the work, he devised the parallel motion as a means of communicating a vertical motion to a rod from a point on a beam which oscillated in an arc.

Beam-fill'ing. (*Masonry.*) Filling-in courses of brick or stone between the ends of beams or joists where they rest upon a wall.

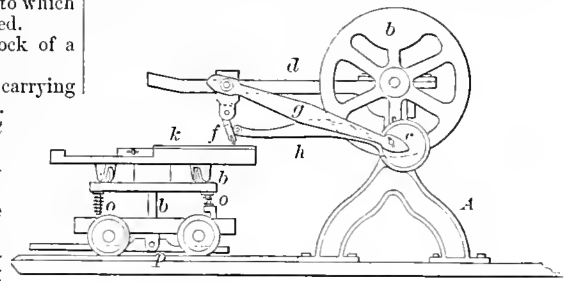
Beam'ing. 1. (*Weaving.*) The operation of winding the yarn upon the beam of a loom.

The yarn-threads are laid uniformly in the order in which they were placed in the *warping-mill* by means of a *separator* or *ravel,* which consists of a number of pieces of cane fixed to a rail of wood, so as to resemble a rake. The threads pass between the teeth, and the yarn is spread on the beam to the required width.

2. (*Leather.*) The operation of working hides with a slicker over a beam.

Beam'ing-ma-chine'. (*Leather.*) One in which hides supported on a sliding or rolling carriage are operated upon by a pendulous slicking-tool which has a vibratory motion. The motion of the carriage brings different parts of the leather under the influence of the tool.

Fig. 614.



Beaming-Machine.

In the illustration, the leather is supported on a rotatable tablet *k* resting on a carriage *o o,* which runs back and forth on rails. The tablet *k* is vertically adjustable by means of the treadle *p b.* The beaming-tool *f* is brought in contact with the leather or raised therefrom by means of the eccentric-rods *g* and rod *h,* which are moved as required by means of the wheels *b c.*

Beam-knife. The two-handled knife used by curriers to shave hides when they are stretched over the beam. See CURRIER'S KNIFE.

Beam-line. (*Shipwrighting.*) The line indicating the intersection of the top of the beams with the frames.

Bean-har'vest-er. (*Agriculture.*) A machine for cutting bean-haulm and placing the vines in windrow, cocks, or in a receptacle of the traveling machine.

There are several forms: —

A hand-puller, having a long row of teeth to catch, and a movable clamp which comes down upon the teeth to grip, the vines.

A machine with a broad, flat oblique share which cuts the roots beneath the surface, followed by lifting-bars which raise, and a rake which collects, the vines in a bunch. By oscillating the rake, the bunch is dumped upon the ground.

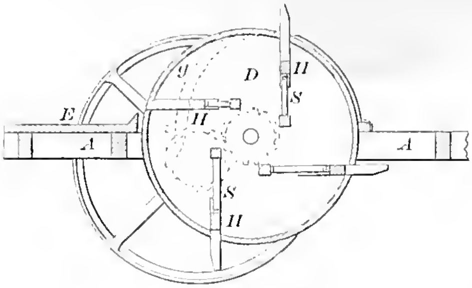
A plow which cuts the vines below the surface, and lifting and directing rods which conduct them to a box on the machine.

A two-wheeled machine, having a rotating wheel with claws which catch, lift, and then deposit the vines in a box on the machine, whence they are dumped in cocks.

A machine with a pair of nearly horizontal toothed wheels rotating in apposition, so as to grasp the vines at the ground surface and lift them so that they may be grasped by a traveling elevator-belt, which deposits them in the box of the machine.

A wheeled machine in which the pullers *H* are guided in and out of a hollow cylinder by a cam-guide *g*, so as to catch the haulm, lift it, and carry it upward and over, and then, by retraction of the

Fig. 615.



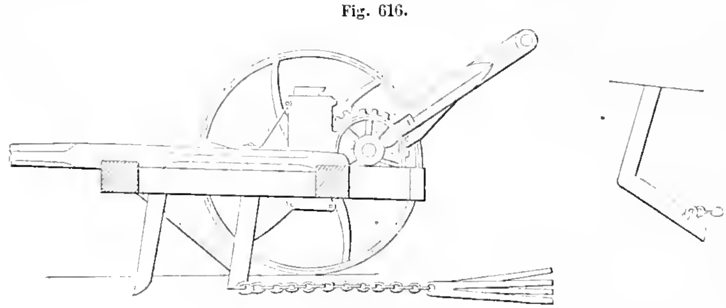
Munger's Bean-Harvester

puller-arms, leave the vines upon the platform *E* on the rear of the frame *A*. The pullers rest upon springs *S* inside the cylinder, and are projected by the same in the intervals of their retraction by the cam-guide.

A form of machine which follows the row of plants, and in which the rotating puller-wheel has a continuous series of pairs of clamps, which close as they come over the row, grasp and lift the vines, and then open to deposit them in a chute which carries them to a transversely moving apron which deposits them.

A machine (Fig. 616) having L-shaped cutters, which sever the vines below the surface of the

Fig. 616.

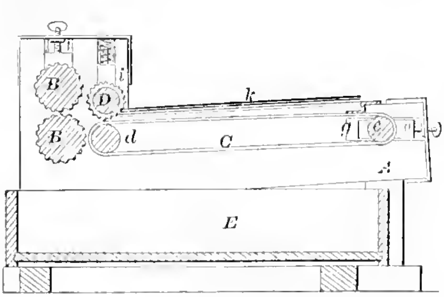


Rosier's Bean-Harvester.

ground, from which they are raised by a trailing device, consisting of diverging prongs, and left upon the surface of the ground.

Bean-mill. (*Husbandry.*) A mill for splitting beans. Used in England in preparing them for horse-feed.

Fig. 617.



Bean-Sheller.

A mill for grinding beans to meal.

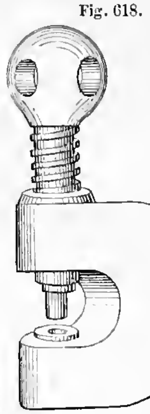
Bean-shel'ler. A machine for removing the hulls from beans. In the example, the pods are fed by an endless apron *c* longitudinally, and cut by the serrated wheels *i*; the toothed rollers *B B* then carry off the hulls, allowing the seed to drop into the receptacle.

Bean-shot. (*Metallurgy.*) Copper in grains. Produced by pouring the melted copper into water.

Bear. (*Metal-working.*)

1. A portable punching-machine for iron plates. A *punching-bear.*

Fig. 618.



Bear.

2. (*Nautical.*) A heavy block shod with matting, and used to scrub the decks.

Beard. 1. (*Carpentry.*) The sharp edge of a board.

2. (*Knitting.*) The hook at the extremity of a needle in a knitting-machine, which retains the yarn.

3. The barb of an arrow or fish-hook.

4. (*Agriculture.*) The awn of grain, as of barley, which is removed by *hummeling.*

5. (*Printing.*) The part of the type between the shoulder of the shank and the face.

6. (*Locks.*) A spring-piece on the back of a lock-bolt of a common kind, to hold with a moderate pressure in either of its positions, and prevent its rattling in its guides.

Beard'ing. (*Ship-wrighting.*) *a.* A beveling or rounding; as of the adjacent parts of the rudder and stern-post, to give the former a greater range of motion without jamming against the latter.

b. The curving of the dead-wood to suit the shape of the ship's body.

Beard'ing-line. (*Shipbuilding.*) The trace of the inner surface of the ship's skin upon the keel, stem, and stern-post.

Bear'er. Anything used by way of support to another weight.

1. (*Carpentry.*) *a.* A member employed to carry other portions, as joists used in supporting lead flats or short pieces to support gutters.

b. A *bearing-partition* is one that supports a structure above.

2. (*Engineering.*) *Bearing-piers* and *bearing-walls* are supporting structures.

3. (*Lathe.*) That part of the lathe which supports the puppets.

4. (*Furnace.*) A supporting bar beneath the fire-bars of a furnace.

5. (*Mill.*) The *housings* or *standards* of a rolling-mill, in which the gudgeons of the rollers revolve.

6. (*Printing.*) *a.* Type or furniture letter-high, to protect the face of the type in printing or stereotyping.

b. The overlay or frisket sheet.

7. (*Music.*) In an organ, one of the thin pieces of hard wood fastened to the upper side of a *sound-board*, to form guides for the register-slides which command the openings in the top of a wind-chest leading to the pipes of the separate systems of pipes which form *stops*. See STOP; ORGAN.

Bear'ing. 1. (*Architecture.*) *a.* The span of a beam between its points of support.

b. The *bearing at the ends* or *wall-support* is the length of the rest on the wall or pier.

2. (*Machinery.*) *a.* The portion of an axle or shaft in contact with its collar or boxing.

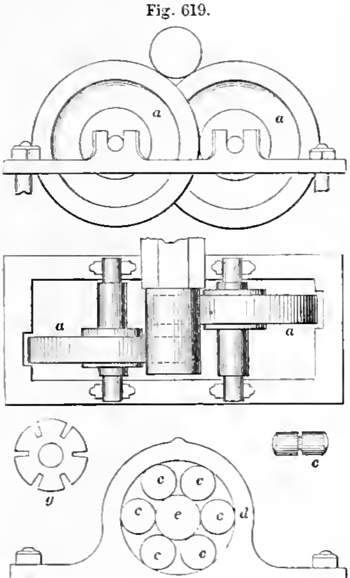
b. The portion of the support on which the gudgeon rests and rotates.

3. (*Vehicle.*) One of the pieces supporting the framework of a carriage and resting on the axle.

4. (*Railroad Engineering.*) One of the chairs supporting the framework of a railroad car or truck, and resting on the journal of the axle, outside of the wheel.

One mode of lessening the friction of journal-bearing consists of a rolling support by means of wheels *a a*. This is familiar in the mode of hanging grindstones.

Fig. 619.



Anti-friction Wheels.

The same idea amplified has been adopted for the axles of cars and carriages, consisting of an annular system of rollers *c c* in the box or hub *d*, which forms a rolling bearing for the axle, the individual rollers of the system rotating on their axes, and in some cases revolving, also revolve around the common axis, namely, the axle of the carriage. *g* is a plate having radial slots in which the rollers *c* are journaled.

In this case the bearings *c c* are rollers, not wheels, as the weight is not imposed upon the axles of the wheels, but on their surfaces. See also STEP.

Bear'ing Bin'na-cle. (*Nautical.*) A small binnacle on the fife-rail, in the center and forward part of the poop.

Bear'ing-neck. The part which revolves within the pedestal brasses, and supports the weight or strain. The journal of a shaft.

Bear'ing-pile. (*Hydraulic Engineering.*) A pile driven as a pillar to bear a superstructure.

When driven till they reach a firm substratum, they may bear a load of 1,000 pounds for each square inch of head.

When standing in relatively soft ground, not over one fifth of the above.

The diameter should not be less than one twentieth of the length. If rocks are expected to be met with, the point should be shod with iron; such shoe may be one hundredth the weight of the pile. An iron hoop binds the head, to prevent spreading. It is driven by a PILE-DRIVER (which see). See also RINGING-ENGINE; MONKEY-ENGINE; PILE-SAW, etc.

Bear'ing-rein. (*Saddlery.*) The rein which belongs to the bridle, and which is attached to the bit and looped over the check-hook in carriage-harness, and over the hames in wagon-harness.

Bear'ings. (*Shipwrighting.*) The widest part of a vessel below the plank-shear. The line of flotation of the loaded vessel when trimmed.

Beat'er. 1. (*Agriculture.*) The striking portion of a thrashing-machine or other mill which acts by percussion.

2. (*Cotton, etc.*) *a.* A scutcher.

b. A blade used in breaking flax or hemp.

3. (*Weaving.*) The *lathe* or *batten* of a loom for driving the *weft* into the *shed*, compacting the fabric.

4. A hatter's mallet.

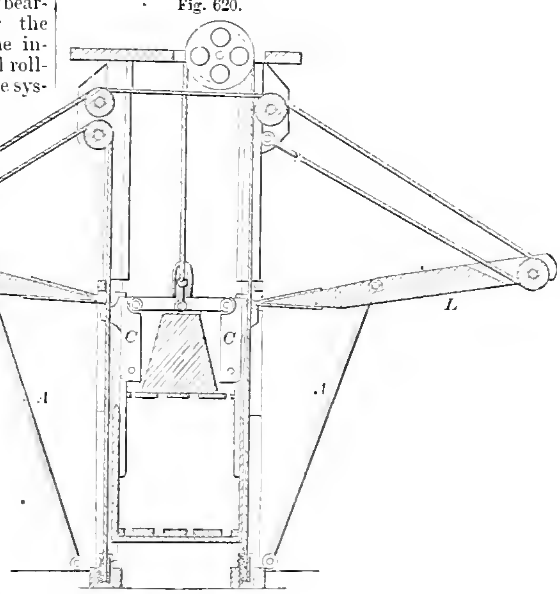
5. (*Knitting-machine.*) Another name for the JACK (which see).

Beat'er-press. For baling. One in which the bale is made by beating it into smaller bulk; or, which is more usual, in which the bale is packed by beating, and finally solidified by direct and maintained pressure.

In the example (Fig. 620), the beater is lifted by means of its toggle-links and pressure-arms *C C*, the latter drawing inward to avoid contact in raising, and the arms become sockets for the ends of the toggles *L L*, when the beater becomes the follower of the press.

The fulcrums of the toggles are formed by the ends of the pivoted rods *A A*, which gradually assume verticality as the outer ends of the toggle-

Fig. 620.



Beater Baling-Press.

levers L ascend, when the rope I is tightened. This is first a *beater* and then a *toggle* press.

In other cases the motive-power is placed a story below the floor of the barn, from whence the hay is charged into the press-box. The draft animal attached to the sweep rotates the capstan, which is made effective either to raise the beater or to move the toggles which raise the lower follower.

Beat′ing. The process of hammering gold or silver into leaf. See GOLD-BEATING.

Beat′ing-brack′et. (*Weaving.*) The *batten* or *lathe* of a loom. The movable bar which closes up the *woof*-threads.

Beat′ing-en′gine. 1. (*Paper-making.*) A machine having a revolving cylinder, with cutters operating against a concave similarly armed, to cut rags into stuff for paper-pulp.

Two or more of such engines are employed: a *washer* operates coarsely upon the stuff; a *finisher* completes the work. The first brings the material to half-stuff, in which condition it is bleached; hence arise the terms STUFF-ENGINE, HALF-STUFF ENGINE (which see).

2. (*Cotton Manufacture.*) The machine in which cotton or other fiber is beaten to rid it of dust, and to loosen it so that it may make a *bat* suitable for farther operations in course. See Fig. 601.

Beat′ing-machine′. (*Cotton, etc.*) A machine in which the bale-cotton is opened and loosened out so as to rid it of the dirt and trash, and deliver it in a comparatively loose *bat.* The machine has many modifications and names: *wolf, devil, opener, willower, scutcher,* etc. See COTTON-CLEANING MACHINE.

Bea′ver. (*Fabric.*) A heavy, milled woolen cloth for overcoats.

Bea′ver-teen. (*Fabric.*) *a.* A cotton twilled goods in which the warp is drawn up into loops, forming a pile. This is left uncut, which distinguishes the fabric from velvet, in which the pile is cut.

b. A strong cotton twilled goods for men's wear. It is a kind of smooth fustian shorn after being dyed. If shorn before dyeing, it is called moleskin.

Be-casse′. (*Nautical.*) A large Spanish boat.

Beche. (*Well-boring.*) A tool for grabbing a rod when it has broken in the bore.

Beck. A vat or vessel used in a dye-house. A *dye-beck* contains a dyeing solution; a *soap-beck* contains soap-suds. See BACK.

Beck′et. (*Nautical.*) A bracket, pocket, loop, or rope to hold spars, ropes, etc., in position, to prevent their swaying about or lying around loose.

Bed. 1. (*Masonry.*) *a.* The line of the direction of the natural strata of stones in the quarry.

b. The horizontal surface of an ashlar or building-stone worked for building or in position; the respective surfaces are the *upper* and *lower* beds. The stone should lie horizontally, as it laid in the quarry.

c. The surface of a voussoir, represented by the abreuvoir. That surface of a quoin in an arch which abuts upon another quoin or a skew-back.

d. A course of stones or bricks in a wall.

e. The lower surface of a brick, shingle, slate, or tile in position.

f. The place prepared for the erection of a wall; the place in which a block or brick is laid.

g. A layer of hydraulic mortar on the extrados of an arch.

2. (*Railway Engineering.*) The foundation of a roadway; in a railway, that part on which the ties immediately rest, including the ballasting.

3. (*Machinery.*) *a.* The foundation-piece of a machine or engine, as the *bed-plate* of a steam-engine, and the same of smaller structures, lathes, drills, etc.

b. The shears of a turning-lathe to which the puppets are attached.

c. The lower die of a punching-machine.

d. The lower stone of a grinding-mill.

e. The table of a planing-machine on which the work is dogged.

4. The wooden block out of which are hollowed the mortars in which the materials for gunpowder are compounded.

5. (*Shipwrightin .*) *a.* The cradle of a ship on the stocks.

b. The part of a bowsprit having the greatest diameter.

6. (*Carpentry.*) The surface in a plane-stock on which the plane-iron is supported.

7. (*Printing.*) The platform of a printing-press on which a form is laid.

8. (*Weapons.*) *a.* A frame for supporting a piece of ordnance, more especially a mortar; as, a *mortar-bed.*

b. The hollowed place in a gun-stock which receives the barrel.

9. (*Vehicles.*) The box, body, or containing receptacle of a vehicle.

10. (*Mining.*) A seam or horizontal vein of ore.

11. (*Domestic.*) An article of furniture to sleep or rest on.

Goose-feather beds and pillows were introduced by the Romans during the government of the Cæsars. They were imported from Egypt. Introduced into England by the returning Crusaders.

Besides feathers, many other substances have been and are still used for beds; as, straw, heather, rushes, hair, corn-shucks, moss, sponge, excelsior (wooden shreds, curled).

Among primitive nations the skins of wild beasts have been much employed, and of these were the beds of the ancient Britons at the time of Cæsar's invasion. Their Roman conquerors are said to have taught them the use of straw; to some extent of grain also, it would seem. The down of the eider-duck of the Scotch cliffs is the softest and most luxurious material.

The beds of the Greeks were according to taste and ability. The poor wrapped himself in a rug, and laid on straw or weeds, with a billet of wood under his head. In cold weather sheep-skins were added. The richer had blankets and fine rugs. When he undressed, he added a linen sheet. He rolled himself up in his bed-clothes.

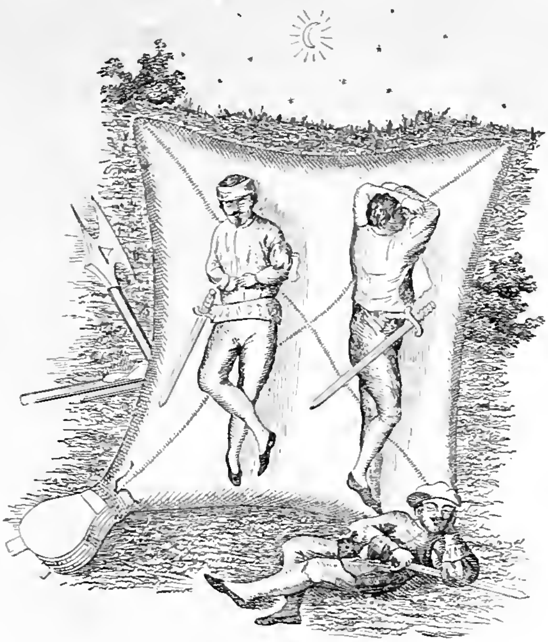
Bedsteads were an afterthought, and even then we find that the occupants swaddled themselves in the blankets. They did not understand, it appears, how to make a partnership matter of it, — bed-clothes of generous area covering a pair. See BEDSTEAD.

Air-beds were known several centuries ago, being made of fabric rendered air-proof by paint or varnish. The annexed cut is from the first German edition of Vegetius, A. D. 1511, and represents some soldiers reposing on one in time of war. The mode of inflation by bellows is also indicated.

We see indications of the same idea in the account given of the sports of Heliogabalus, who had collapsing cushions wherewith he tricked his guests. See AIR-BED. See also HYDROSTATIC BED.

We are indebted to Dr. Arnott for the invention of the water-bed, which was contrived by him for the purpose of supporting the body without sensible inequality of pressure, thus preventing bed-sores. Clark, in 1813, and MacIntosh, in 1823, improved the matter by contributing a better material. The

Fig. 621.



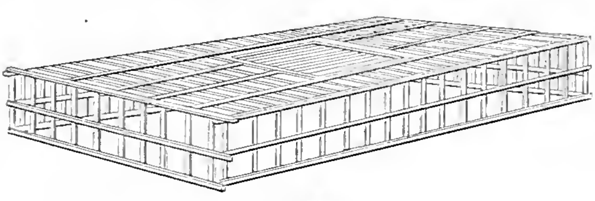
Air-Bed

india-rubber cloth was long known simply as "Mac-intosh."

Bed-bot'tom. A device attached to a bedstead on which the bed immediately rests. The object to be attained is to secure sufficient strength with a certain degree of elasticity, and for this purpose many contrivances have been devised, among the best known of which is probably the old-fashioned "sacking" bottom, having eyelet-holes around its margin, through which a rope was passed for securing it to pegs on the bedstead. Another common arrangement is merely a series of slats passing from side to side and resting in notches on the rails.

The framework in the accompanying cut is made from the sticks of the palm-branch; so says Wilkinson. It, and other structures similarly made, are known by the general name of *kaffass*. The bedstead of palm-branches, called a *bais*, and mentioned by Porphyry, was probably of this kind. It probably formed the body of some of the couches and ottomans represented in the ancient paintings on the Egyptian tombs. The bed-bottoms made in this way are usually 7 by 3½ feet, and from 1 to 2 feet in hight.

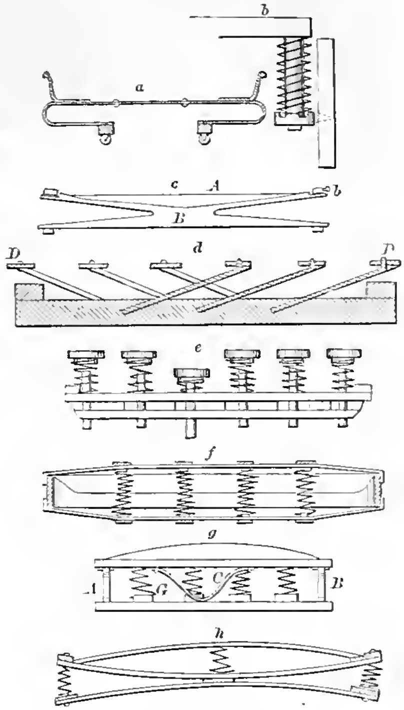
Fig. 622.



Egyptian Mattress.

In Fig. 623 are shown several varieties, some in section and others in elevation.

Fig. 623.



Bed-Bottoms.

a, the longitudinal spring-slats are curved over at the ends and attached to the cross-bars.

b, the slat-ends rest on springs whose lower coils rest on lugs with shanks which screw into the rail.

c has spring-bars *B* and a tension-wire *A*.

d has spring-pieces inserted obliquely into the slat.

e has disks and spindles, spring supported.

f has spiral springs between upper and lower webs.

g has springs supporting an upper padded frame.

h has a system of curved springs, slats, and spiral springs.

The above is a mere sample of hundreds of varieties. Woven wire fabric or rattan is the best in warm weather.

Bed-clothes Clasp. A device for preventing the accidental displacement of bed-clothes; as, for instance, a pair of pivoted jaws kept closed by a spiral spring and fastened to the bedstead.

Bed'ding. The seat on which a boiler or other structure rests. See Bed.

Bed'ding-stone. (*Bricklaying.*) A marble slab, accurately level, on which the rubbed side of a brick is tested to prove the truth of its face.

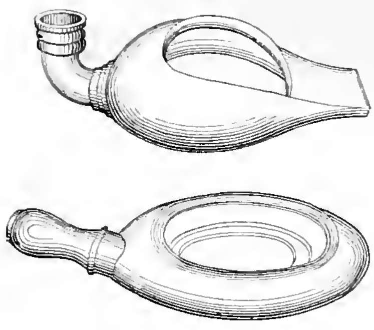
Bede. A miner's pickaxe.

Bed-lathe. The usual form of lathe, in which the puppets and rest are supported upon two parallel and horizontal beams or shears.

Bed-mold'ing. A collective term for all the moldings beneath the corona or principal projecting member of a cornice, which, without bed-moldings, would appear too much like a mere shelf.

Bed-pan. (*Domestic.*) A convenience for the sick-room, for the use of invalids or the bedridden.

Fig. 624.



Bed-Pan.

Bed-plate. (*Machinery.*) The foundation-plate to which the frame of a machine is bolted, as of a steam-engine.

In BLANDY's portable engine, the engine and working machinery are all attached to a continuous hollow iron bed-plate in the form of a cylinder. The feet for this bed-plate fit into seats on the boiler, so as to be removable therefrom when required. The principal object is to prevent the unequal expansion of the boiler and engine from throwing the latter *out of true*, or from straining the joints of the former.

Bed'stead. A piece of furniture supporting a mattress or bed.

Bedsteads were common in Egypt and among the later Greeks. They were only used, however, by the wealthier classes. Many ornate bedsteads are represented in the tombs at various parts along the river Nile.

Among the earlier notices is the iron bedstead of Og, king of Bashan; it was nine cubits long and four broad (Deut. iii. 11). This was adapted for a man twelve feet high. The Rabbinical writers have exercised their ingenuity upon Og, and their highest flight concerns a bedstead, the first mention of the article in their chronicles. Rabbi Ben-Somebody — we merely condense — says that Og lived before the flood, and was so tall that the water did not reach his knees, and so he waded through. Escaping this destruction, he afterwards turned up as Eliezer of Damascus, Abraham's servant. Abraham was of a size equal to 74 ordinary men, but was no match for Eliezer, except in scolding, which he could do most profoundly. As he was blowing up Og one day, the latter trembled so violently as to jerk out a double tooth, which the patriarch converted into an ivory bedstead. It was probably carious, and so Abraham sawed off the fangs to bring them to a length for legs, and shoveled out the hole so as to hold a few camel-loads of straw. Abraham appears to have discharged him, or Og ran away, and again appears in opposition to Moses, who killed him.

Rabbi Jochanan admits that the above is only tradition, but says that he himself chased a roe into the hollow shin-bone of the defunct, and followed it three miles without finding his roe or the end of the hole. He became tired and returned disgusted. A huge — bone.

The bedsteads of the luxurious Greeks had four rails, legs, straps to support the mattress, a head-board, and sometimes a foot-board. They were made of solid maple or boxwood; sometimes veneered with costlier wood, tortoise-shell, or ivory. They had ornamental feet, sometimes of silver.

The mattress was of linen, woolen cloth, or leather, and stuffed with straw or wool. Round and square pillows were used. They were provided with soft and thick woolen blankets and sheets. The Greeks wore nightgowns. The sleeping arrangements of the wealthy Greeks seem to have been good, but the Asiatics said "the Greeks do not know how to make a comfortable bed."

> "But no town with Miletus vies
> In the bridal-bed's rich canopies."
> CRITIAS; quoted by Athenæus, A. D. 220.

The Roman bedsteads were magnificent, and the weary climbed on to them by step-ladders on the open side; the other was closed by a side-board. The open side was *sponda*, the closed *pluteus*; the latter for the weaker vessel.

The mattresses or beds were stuffed with wool or feathers.

We cannot spare room to describe the gorgeous counterpanes.

The bedsteads had canopies, but we do not read of curtains or testers.

The bed, or rather bedstead, of Ware, mentioned by Shakespeare, is still in existence, and is to be seen at one of the inns in that village. It is twelve feet square. Many innovations have been made on the old-fashioned four-post bedstead. That known as the four-poster was, however, provided with four high posts and a tester, forming, with the curtains, a complete canopy by which the sleeper, if so disposed, could be fully protected against fresh air, and enjoy the pleasure of breathing as vitiated an atmosphere as he pleased.

It was formerly the general practice to make the bed-bottom of coarse canvas, having eyelet-holes along its edges, through which a cord was passed, and thence over pins in the side, top, and bottom rails, which supported the bed-bottom, the arrangement admitting of being laced up as tight as desired. Of late, various arrangements of slats have prevailed. See BED-BOTTOM.

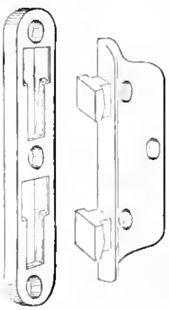
Many improvements have also been made in the manner of putting the parts together, so that the bedstead can be set up and taken down with greater facility.

Invalid-bedsteads are made with rising sections, so as to bring the body to a reclining or sitting posture for relief by change of position.

Wardrobe-bedsteads are modes of concealing beds in chambers to be occupied during the day, where the accommodations of the domicile are limited.

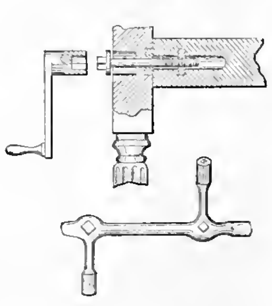
Bed'stead-fast'en-er. A device consisting of two parts, one attached to the end of the rail, and

Fig. 625.



Bedstead-Fastener.

Fig. 626



Bedstead-Wrench.

the other to the side of the bed-post, by which the parts are locked together or readily detached.

There are many varieties: some of metal; others screws on the rails and screw-sockets in the posts, dovetail tenons on the ends of the rails and slots or sockets in the posts, etc.

Bed'stead-key. See BEDSTEAD-WRENCH.

Bed'stead-wrench. A crank-wrench employed in turning the bolts which secure the rails to the posts of bedsteads. A nut is inserted at a lateral mortise in the rail, so as to present its aperture in the path of the screw-bolt, which is rotated by the wrench. A tenon on the end of the rail fits into a mortise in the face of the post.

Another form combines sockets of various sizes and a screw-driver.

Bed-stone. (*Milling.*) The term applied to the lower or stationary mill-stone. The lower stone, however, in some mills, is the runner. In some mills, again, the stones are driven in contrary directions. The term *bed-stone*, in such cases, loses its significance, and it becomes the *runner* or the *lower runner* respectively.

Bed'way. (*Mining.*) An appearance of stratification, or nearly horizontal line of marking in granite.

Bee. (*Nautical.*) One of the pieces of plank bolted to the outer end of the jib-boom to reeve the foretop-mast stays through.

Bee-block. (*Nautical.*) One of the blocks of hard wood bolted to the sides of the bowsprit-head, for reeving the foretop-mast stays through.

Bee-feeder. (*Husbandry.*) A device for feeding bees in bad weather or protracted winters. For the materials of the food, see Langstroth or other apiarists. The mode is usually a small perforated piece of board which floats on the liquid food.

Bee-fu'mi-ga-tor. (*Husbandry.*) A blower for driving a smudge into a hive to expel the bees, or compel them to retire to a certain part of the hive, while honey is removed, or the hive examined and cleaned. Fumigation is also used to partially paralyze the bees while the swarm is being parted.

Bee'hive. (*Husbandry.*) A box, crate, basket, or hollow log in which bees are kept for the sake of their honey. In the old scripture and classic lands they lived, and yet live, in the clefts of the rocks. They are new-comers to this hemisphere, and with us live in a wild state in hollow trees. In California, it is said, they have taken to the cliffs. A sawed-off section of a hollow log is known in the West and South as a *gum*, possibly from the use of a log of the *gum-tree* for that purpose. Whether for a beehive or a curb for a spring it bears that name; and the gum-wood is only common in some localities, whereas the name is universal.

Hybla and Hymettus are classic bee-ground. Eumelus of Corinth wrote a poem on bees 741 B. C. There are enumerated 292 species of the apis genus. The honey-bee was introduced by the English into Boston, 1670, and is spreading over the continent. The men were lately alive who professed to recollect the time when the swarms first made their appearance on the west side of the Mississippi. They are said to keep a little in advance of civilization. Huber wrote on bees in 1796, and the bee-anatomists and physiologists are but his followers.

Samson found a swarm of bees in the land that flowed with milk and honey. Honey was prohibited as an offering on the altar under the Levitical law, but its first-fruits were presented for the use of the priests. (Lev. ii. 11, 12.)

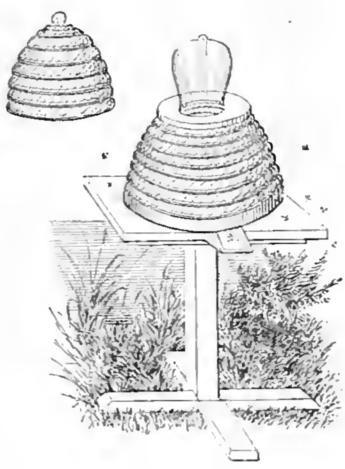
Honey was a favorite article of food in ancient Egypt, but the tombs are silent as to the treatment of the bees.

Varro (50 B. C.) recommends that hives be made of basket-work, wood, bark, hollow trees, pottery, or reeds, and be contractible according to the size of the swarm. He recommends a pane of transparent stone (*lapis specularis*), so as to enable the apiarian to see the bees at work.

Sallust recommends cork; a very good suggestion. They are yet made of cork in some parts of Southern Europe; the wood being removed, leaves the cork-bark as a cylinder. In Greece and Turkey earthenware hives are in common use. The ancient English hives were baskets of unpeeled willows.

Beehives made of helical coils of twisted straw are in common use in England, as well as those of wood. A representation of one of the former kind is shown in the illustration, the cover being removed to show the interior glass cap. The materials of which hives are made differ in various countries, and the variations in construction are almost infinite.

Fig. 627.



Straw Beehive.

Pepys thus refers to glass beehives: —

"After dinner to Mr. Evelyn's; he being abroad, we walked in his garden; and a lovely, noble ground he hath indeed [Sayes Court]. And, among other rarities, a hive of bees; so as, being hived in glass, you may see the bees making their honey and combs mighty pleasantly." — *Pepys's Diary*, April, 1665.

Movable comb-hives were invented in 1792. In their present form and adaptation they are considered the invention of Langstroth.

In some countries it is usual to carry bees from place to place in their hives for change of pasture. This practice is extensively carried on in Egypt, where great numbers of hives are often transported on boats from place to place along the Nile, according to the succession of flowers in different districts. An analogous custom of transporting bees from one locality to another, for similar reasons, has long been prevalent in Persia, Asia Minor, and Greece; and in Scotland, during the season when the heather is in bloom, many hives are annually carried to the heaths from districts not in their immediate vicinity.

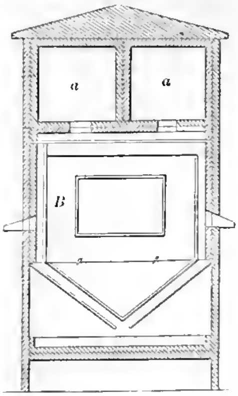
In Poland, the bees are transported in large colonies from their winter-quarters to their summer pasture, and back again when the weather becomes inclement.

The objects principally held in view in the manifold attempted improvements in beehives are the prevention of the access of moths to the hive, and the separation of the portion containing the spare honey from the breeding portion. It is also desirable that perfect ventilation and ready access to any part of the hive should be attained, and that there should be no difficulty in removing the surplus honey.

These, and other considerations involving cheapness, have been the subjects of improvements almost innumerable.

Fig. 628 is a fair illustration of one favorite form of hive. It is suspended by cleats on the sides. It has a large breeding-chamber *B*, a glass door, and a sloping floor to carry off dirt. Above are two sliding, removable boxes *a a* for the abstraction of honey without disturbing the contents of the main chamber.

Fig. 628.

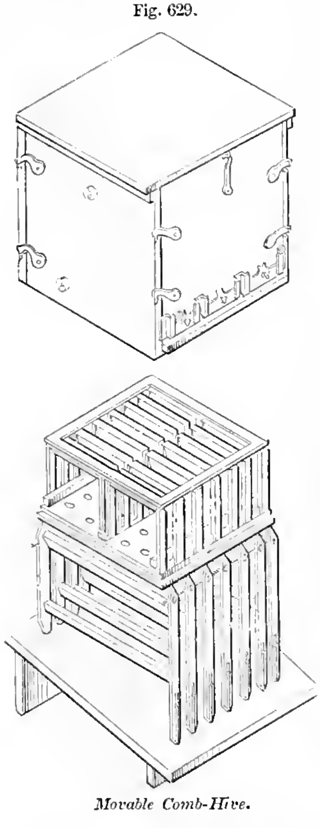


Suspended Beehive.

Fig. 629 shows the arrangement of movable combs in a box whose sides are removable from the interior works. The upper series of combs are for removal of honey.

In Fig. 630, the hinged top and spare honey-box compartments admit of being lifted from the lower breeding-hive; the entrance to the lower hive is regulated by an invertible bee-trap with swing-bars, by which the size of the apertures may be changed. A groove is cut in the bottom for a moth-trap, which may be opened by dropping a hinged lighting-board. Sectional frames have varying gains on their different sides, which, by connection with the entrance-slot, may prevent the queen or drones from passing through or impeding the passage of the workers.

Fig. 629.

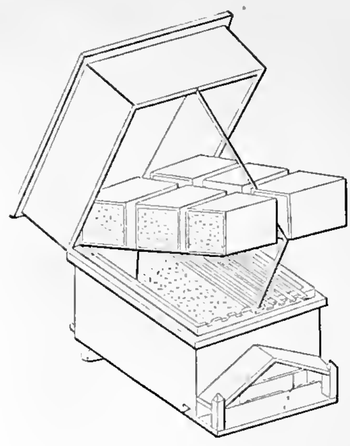


Movable Comb-Hive.

Bee'hives, Swarm-in'di-ca-tor for. (*Husbandry.*) An arrangement for detecting the gathering of a swarm previous to their departure in quest of other homes and pastures new. It is usually an alighting-board, so arranged as to cause an alarm when a certain weight of outlying bees has accumulated upon it, — this being their habit previous to flight.

Many of the improvements in hives have special reference to preventing swarming, by division of the inmates into two bodies with room for expansion of each party. These attempts to anticipate or defeat the natural inclinations of these little *Hymenopteras* are only partially successful.

Fig. 630.



Kretchmer's Beehive.

Beer. A fermented infusion of malted grain, to which hops is usually added.

The term is also applied to beverages made of infusions of roots and herbs.

"When the vine would not grow and be fruitful, Osiris taught the inhabitants to make drink of barley, little inferior in strength and pleasant flavor to wine itself." — DIODORUS SICULUS (60 B. C.).

Hecatæus, in his "Description of the World," refers to the Egyptian beer. Sophocles and Æschylus also. The latter, —

> "And after this he drank his beer, and much
> And loudly bragged."

Athenæus says that Thracians and Pæonians drank of barley-wine, or a similar drink made from millet or other grain.

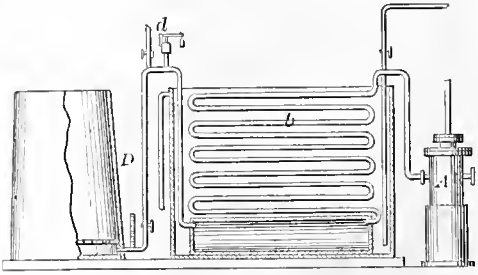
"Polybius describes the palace of one of the Spanish kings as being [furnished with] huge silver and gold goblets full of the wine made of barley." — ATHENÆUS.

"Aristotle says that wine of grapes is stimulating, but that of barley has a tendency to stupefy." — *Ibid.*

Beer-cool'er. (*Brewing.*) *a.* A large shallow vat or cistern in which the beer is exposed to the air to cool.

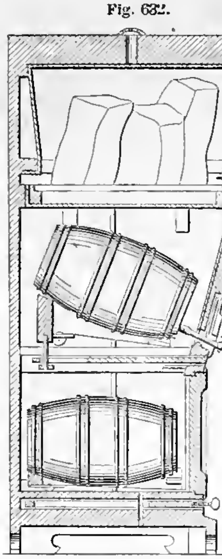
b. A tub or cistern in which beer is exposed to cooling influences mechanically exerted, as in Fig. 631, in which air is driven by the pump *A* through the worm *b*, which is in a cistern of ice-cold water,

Fig. 631.



Beer-Cooler.

Fig. 632.



Beer-Cooler.

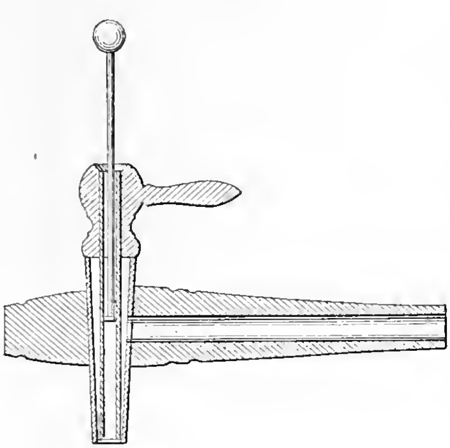
and escapes in jets through the beer in vat *D.* *d* is a safety-valve.

In another form the beer-vat has a jacket in which ice-cooled water circulates. The devices are numerous.

Fig. 632 shows a form of beer-cooler in which the kegs are kept in a refrigerator; the ice being in the upper chamber, the cooled air descends by gravity.

Beer-fau'cet. For draining certain descriptions of beer it is desirable to foam it, which is done, when the beer has not life enough of its own, by means of a piston which ejects air along with the beer into the glass or pitcher. As the piston descends, air is ejected at the central aperture, mixing with the beer, which passes out at the annular orifice around the air-opening.

Fig. 633.



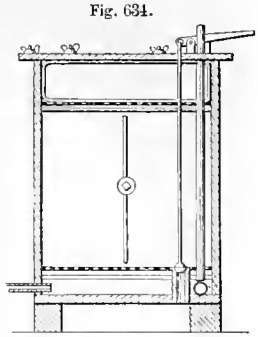
Beer-Faucet.

Beer-float. (*Distilling.*) An areometer or hydrometer designed to ascertain from the observed density of a grain-wash the possible yield of spirit therefrom. The scale of the instrument is graduated to indicate directly at the standard temperature the percentage by volume of proof-spirits that the mash will yield, provided the fermentation proceeds to a point where its density is equal to that of water.

Beer-foun'tain. A form of pump used in drawing beer into a glass for immediate consumption. It generally consists of a lever mounted in an ornamental stand, and connected to a piston in a pump which raises the beer from the cask and ejects it at the faucet by the lever.

Beer-hop'per. A vat or beck in which the infusion of hops is made, to be added to the wort.

Fig. 634.



Beer-Hopper.

The hops to be treated are placed upon the false bottom, and the liquor is then introduced, and steam let into the lower compartment. Pipes are provided for drawing off the liquid, preventing its overflow, and conducting the aroma. The stirring device is removable, to allow the false bottom to be taken out.

Beer-ma-chine'. A machine consisting of a number (say three to eight) of lift or force pumps, which connect with as many casks of different qualities of malt-liquor in a cellar, and are operated by oscillating handles in a neat case at the counter where the liquor is drawn. The faucets are arranged in a row over a sink which catches the drip. The affair is one of the polished appointments of a bar-room.

Beer-vat. (*Brewing.*) One in which the infusion of the malt is made, constituting the wort or sweet unfermented liquid, which, with the added infusion of hops and the resulting fermentation, becomes beer.

Bee'tax. (*Agriculture.*) An instrument for paring turf.

Bee'tle. 1. A heavy mallet or wooden hammer used in driving wedges, solidifying the earth, etc. Also called a *maul.* The handle is at right angles to and passes through the head, like a hammer; and, like the latter, receives a swinging motion, the shoulder being the center of vibration. The rammer, on the contrary, receives propulsion in the direction of its length, as the pavior's rammer, the ramrod, etc.

The beetle was used by the Greeks to bruise olives at the press.

The pavior's rammer is sometimes made so large as to be operated by several men. Perhaps it was to a large maul that Falstaff referred: —

"If I do, fillip me with a three-man beetle."

2. (*Cotton.*) The *beetling-machine* formerly used in cotton-mills consisted of a long series of vertical stamps, lifted consecutively by studs set spirally on a horizontal rotating shaft, and coming down upon the cloth as it was wound upon a roller rotated slowly beneath. The action is similar to the ore-stamps of the mines.

Bee'tle-head. The weight or *monkey* of a pile-driver.

Beet-root Su'gar Ma-chin'er-y. The process consists in: —

1. *Washing* the roots in a rotating drum of laths submerged in a cistern of water.

2. *Rasping* to a pulp by a hollow studded cylinder, against which the roots are pressed, a jet of water keeping the drum clear of the pulp.

3. *Pressing* the pulp in woolen bags in a hydraulic press to remove the saccharine juice. Pecqueur substitutes a force-pump action and foraminated cylinders covered with wire-gauze. The cane-rolling mill has also been used.

4. The resulting juice is heated to 140°, defecated by hydrate of lime, filtered and evaporated in a vacuum-pan. See CONDENSER; EVAPORATOR; VACUUM-PAN; SUGAR-MACHINERY; DIFFUSION APPARATUS.

Maceration and *desiccation* have each been tried with some degree of success. The first notice we find of the making of beet-root sugar was in 1747.

ACHARD's (French) process made the manufacture a success in 1799.

Napoleon encouraged it when the English cruisers destroyed the commerce of France, and cut her off from her sugar-producing colonies.

It is now being tried in Illinois, Utah, and California.

Be-lay'ing-pin. (*Nautical.*) A stout pin in the side of a vessel or round the masts, used for fastening or *belaying* ropes.

There are several contrivances for belaying, differing especially in size. We may cite : —

Belaying-pin.	Cleat.
Belaying-cleat.	Kevel.
Belaying-bitt.	Riding-bitt.
Chess-tree.	

Bel'fry. 1. A warlike machine in the form of a tower, formerly used in sieges as a cover while firing on the enemy.

2. (*Architecture.*) *a.* A tower, either forming part of a building or detached, in which bells are suspended.

b. The apartment in a tower, etc., in which the bells are placed.

Bell. 1. *a.* A hollow, cup-shaped, metallic object suspended by a neck, and sounded by a swinging clapper.

b. A hollow, metallic sphere sounded by a loose ball in its interior.

Bells are of very great antiquity, small golden bells being mentioned in Exodus xxviii. 34, as forming, alternated with pomegranates, ornaments upon the hem of the high-priest's robe. Small bells, composed of an alloy of 10 copper and 1 tin, were found by Layard at Nimroud.

Bells (*tintinnabulum*) in ancient Greece and Rome were of various forms, hemispherical, pyramidal, sometimes like the modern flaring or the Chinese pattern. They also used flat disks, like gongs.

They were used for lustrations ; frames with bells of varying sizes and pitch were used in religious observances. They were hung at the outer doors of houses, as often to notify passers that somebody was coming out as that some one awaited leave to enter, for the doors uniformly swung outward into the street. They were used to awaken the family or call them to meals (Seneca). They were used publicly in the camps and garrisons, on triumphal cars, and Plutarch alludes to their use in the fish-market ; they were also carried by the night-watch. They were hung upon horses, cattle, and sheep, as with us, to trace them in case they should stray. According to Pliny, the monument of Porsenna was decorated with bells. Lars Porsenna, of Clusium, he who halted at the Tiber, was contemporary with Daniel.

After this statement it seems futile to simply repeat the legends of the introduction of bells into Europe in the fifth and sixth centuries, as if they were then a new thing.

Sheep-bells of bronze were used in ancient Italy, and are yet preserved in the Museum of Naples. Then, as now, the sheep made periodical migrations from their lowland winter pastures to their mountain summer pastures, like those subject to the code of laws "La Mesta" of Spain. See MERINO. Varro refers to his flocks wintering in Apulia, but spending the summer on the mountains of Samnium.

Bells are said to have been introduced into Christian churches about A. D. 400 by Paulinus, Bishop of Nola, in Campania ; into France about 550. They were mentioned by Bede, and are known to have been used in England prior to the year 700. Bells were first cast in England in the reign of Edmund, A. D. 940.

In A. D. 610, Clotaire II., king of France, besieged Sens, when Lupus, Bishop of Orleans, ordered the bells of St. Stephen to be rung. The sound so frightened Clotaire that he gave up the siege. So they say.

Pope John IX. ordered bells to be rung as a defence against *thunder* and lightning, A. D. 900.

All the bells in Europe were rung in 1456, by order of Pope Calixtus III., to scare away Halley's comet, which was supposed to be in some way identified with Mohammed II., who had just taken Constantinople. The comet left, but Mohammed stayed.

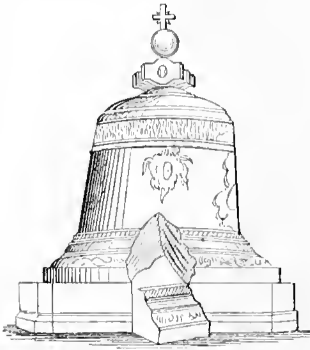
Most of the bells of Western Europe appear to have been hand-bells, of which some curious examples are still preserved. They are made of thin plates of hammered iron, bent into a four-sided form and brazed together at the corners. One of these, said to have belonged to St. Patrick, is preserved in the city of Belfast. For a long period they were made of comparatively small size. One in a church at Orleans, in the eleventh century, weighed 2,600 pounds, and was considered as remarkably large at that time.

During the thirteenth century much larger bells began to be cast. The "Jacqueline," at Paris, cast in 1300, weighed 15,000 pounds ; one cast at Paris in 1472 weighed 15,000 pounds ; and the bell of Rouen, cast in 1501, weighed over 36,000 pounds.

"One of the pieces in my collection which I the most highly value is the silver bell [made by Benvenuto Cellini] with which the Popes used to curse the caterpillars, — a ceremony, I believe, now abandoned. Lahontan, in his travels, mentions a like absurd custom in Canada, the solemn excommunication by the bishop of the turtle-doves, which greatly injured the plantations. For this bell I exchanged with the Marquis of Rockingham all my Roman coins in large brass. The rilievos, representing caterpillars, butterflies, and other insects, are wonderfully executed." — HORACE WALPOLE.

The bell known as the "Liberty Bell," which, on the 4th of July, 1776, announced the signing of the Declaration of Independence, was cracked while being rung in honor of the visit of Henry Clay to Philadelphia, and since then has been on exhibition in that city, together with other Revolutionary relics. The following inscription, taken from Leviticus xxv. 10, surrounds it near the top : "Proclaim liberty throughout the land, unto all the inhabitants thereof."

Fig. 635.



Great Bell of Moscow.

The Russians have surpassed all other European peoples in the size of their bells. The great bell of Moscow, cast by the orders of the Empress Anne in 1734, was by far the largest made by them, being 21 feet in hight, and weighing 193 tons. It remained suspended only until 1737, when it fell in consequence of a fire, and remained partially buried in the earth until 1837, when it was raised, and now forms the dome of a chapel formed by excavating the earth underneath it. It has been denied that this bell ever was suspended.

Says a correspondent of the "New York Observer": "In Russia the bell is an instrument of music for the worship of God as truly and really as the organ in any other country. This is the key to what would otherwise be difficult to explain.

"The bell is a medium of communication with *the Infinite*, and the worship of a people and an empire finds expression in the majestic tones of a bell, and it ceases to be a wonder that a bell should have a tongue which requires twenty-four men to move, and whose music sends a thrill of praise into every house in the city, and floats away beyond the river into the plains afar.

"Moscow is the 'holy city' of the Greek Church. Pilgrims come hither from thousands of miles off, and on foot, and sometimes without shoes. When they draw near the city, and on the evening air the music of these holy bells is first borne to their ears, they fall upon their faces prostrate, and worship God. If they could go no farther, they would be content to die there, for they have heard the bells of Moscow, and on their majestic tones their souls have been taken up to heaven! This is the sentiment of the superstitious peasant, and it is a beautiful sentiment, — ideal, indeed, but all the more delicate and exalted. *We* use the bell simply to call the people to the house of worship; they speak to us. *Their* bells praise God. They cast their silver and their gold into the molten mass, and it becomes an offering, as on an altar, to Him who is worshipped with every silvery note and golden tone of the holy bell.

"Ascending the Ivan tower, we find on three successive stories bells to the number of thirty-four. Some of these are of a size to fill one with astonishment had he not seen the giant below. The largest is on the first story above the chapel, and weighs more than 127,830 pounds. It swings freely and is easily rung. I smote it with the palm of my hand, supposing that such a blow could not produce the slightest vibration in such a mighty mass of iron; but it rang out as clear and startling as if a spirit within had responded to my knock without. Two bells are of solid silver, and their tones are exquisitely soft, liquid, and pure. It was exciting to go from one to another and strike them with their tongues or with your hand, and catch the variety and richness of their several melodies.

"I had come down from the Kremlin to my lodgings, and, wearied with the wanderings of the day, was lying on the bed and looking out on the city. It is just before sunset, and the day has been oppressively warm. A delicious glow from the gorgeous west is bathing all the domes and roofs with splendid colors, and silence is stealing in with the setting sun upon the crowded city. It is the eve of one of the most holy festivals of the Greek Church. One vast church edifice is directly in view of my window, and but a short way off.

"As I lie musing, from this church near at hand comes the softest, sweetest tone of an evening bell. Another tone responds. A third is heard. The Ivan tower on the hight of the Kremlin utters his tremendous voice, like the voice of many waters. Then all the churches and towers over the whole city, — four hundred bells or more, — in concert, in harmony, 'with notes almost divine,' lift up their voices in an anthem of praise such as I never thought to hear with mortal ears, waves of melody, an ocean of music, deep, rolling, heaving, changing, swelling, sinking, rising, sounding, overwhelming, exalting."

"Keeping time, time, time,
In a sort of Runic rhyme."

The Chinese have likewise produced bells of colossal size, one of which, at Pekin, weighs 130,000 pounds; but the tone of their bells is said to be discordant and "panny," like that of their gongs.

The great bell of Burmah, at a temple in the environs of Amarapoora, is slung on a triple beam cased and hooped with metal, and resting on piers of brick-work. In the upper part are visible the chains of iron around which the metal of that portion was run, to strengthen it at the point of suspension.

Its dimensions are as follows: —

External diameter at the lip	16 feet 3 inches.
External diameter 56 inches above the lip	10 "
Interior hight	11 " 6 "
Exterior hight	12 "
Interior diameter at top	8 " 6 "
Thickness	6 to 12 "
Weight, about	260,000 pounds.

Klaproth states that in an edifice before the great temple of Buddha, at Jeddo, is the largest bell in the world.

"It is 17 feet $2\frac{1}{2}$ inches in hight, and weighs 1,700,000 pounds English. Its weight is consequently nearly four times greater than the great bell at Moscow, and 56 times larger than the great bell at Westminster, England."

The bell suspended from a tripod and hand-bells are regular accessories in Japanese bands, if such they may be termed.

As among the Slavonic nations, the bell is the great musical feature of Tartarian worship: —

"The Lamas execute a kind of music little in concord with the melodious gravity of the psalmody. It is a stunning noise of bells, cymbals, tamborines, conch-shells, trumpets, whistles, etc." — ABBÉ HUC, *Travels in Tartary.*

The Chinese and Mandshu words for bell are onomatopoetic, being respectively *tsiang-tsiang* and *tang-tang.*

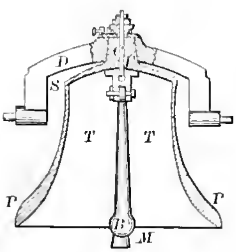
The weight, dimensions, and date of casting, of some of the largest bells in the world are stated to be as follows: —

	Weight. Pounds.	Diameter. Ft. In	Thickness. Inches.
Moscow (Kremlin),			
Cast in 1553	36,000		
Cast in 1654	288,000		
Fell in 1703.			
Recast in 1733	432,000	21.	23
Broken in 1737.			
Moscow (St. Ivan's)	127,830		
Burmah (Amarapoora)	260,000		
Pekin	130,000		
Novogorod	62,000		
Vienna (1711)	40,200	9.8	
Olmutz	40,000		
Rouen	40,000		
Sens	34,000	8.6	
Erfurth	30,800		
Westminster ("Big Ben," 1858)	30,324		
London (Houses of Parliament)	30,000		
Paris (Notre Dame, 1680)	28,672	8.6	$7\frac{1}{2}$
Montreal (1847)	28,560	8.6	$8\frac{1}{4}$
Cologne	25,000		
New York (City Hall)	23,000	8.	$6\frac{1}{2}$ to 7
New York (Fire-alarm, 33d Street)	21,612		
York ("Great Peter," 1845)	$10\frac{3}{4}$ tons.	8.3	

	Weight. Pounds.	Diameter. Ft. In.	Thickness Inches.
Bruges . . .	23,000		
Rome (St. Peters, 1680)	18,600		
Oxford ("Great Tom," 1680) . . .	18,000	7.1	$6\frac{1}{8}$
Antwerp . .	16,000		
Exeter (1675) . .	$5\frac{1}{2}$ tons.	6.3	5
Lincoln ("Great Tom," 1834) . . .	$5\frac{1}{2}$ tons.	6.8	6
London (St. Paul's, 1709)	11,470	6.7	

Fig. 636 represents a bell having a rotatable clapper. The various parts are —

Fig. 636.



Bell.

B, clapper or tongue.
C, clapper-bolt.
D, yoke.
F, canon or ear.
M, mouth.
P, sound-bow.
S, shoulder.
T, barrel.

Cattle and *sheep* bells are cast, or are made of wrought-metal by being doubled over at the angles or cutting and brazing. Each carries its clapper.

Harness and *sleigh* bells are sometimes made as others, with a suspended clapper in the usual bell-shaped article, but are generally hollow spheres with perforations, and contain globes of iron which have free play and give a sharp jingle rather than a sonorous and prolonged note.

Call bells are used for the table or desk to summon a servant or messenger in the vicinity.

Chimes, or peals of bells, are of very ancient date, the first chime introduced into England having been put up at Croyland Abbey, A. D. 960, and to this day that country is noted for the number and variety of its peals of bells, which are an institution of almost every village church.

The making and arrangement of a suit of bells to constitute a perfect chime is a matter of considerable difficulty. The tone of a bell depends conjointly on its diameter and thickness, a small or thick bell yielding relatively a more acute sound than one which is larger or thinner, owing to the greater rapidity of the vibrations of the metal. The founder endeavors to regulate the diameter and thickness so as to produce a certain note in each bell of a set of chimes; but as this is difficult to be attained by the mere operation of casting, it is generally necessary to remove some of the metal afterwards to produce a perfect note, by either reducing the diameter at the lower edge when the note is too low, or reducing the thickness of the part struck by the clapper when too sharp. See CHIME.

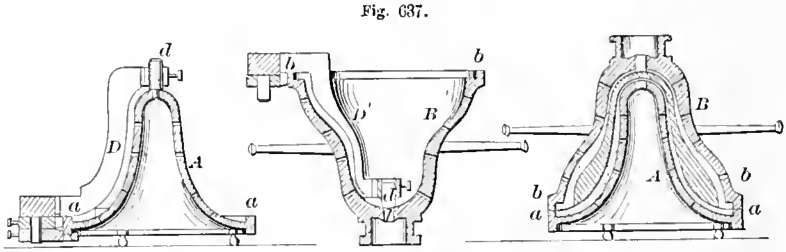
The thickest part of the bell is that struck by the clapper, and is called the *sound-bow*. Among the German bell-founders this is taken as the unit of construction, and being considered as = 1, the most approved proportions are: diameter at the mouth, = 15; diameter at the top, = $7\frac{1}{2}$; hight, = 12; and the weight of the clapper = $\frac{1}{40}$ of the weight of the bell.

The casting of small or house bells is performed in a manner similar to that of other small brass or bronze castings; but with the larger bells, furnaces capable of melting large quantities of metal are required. For very large bells the mold is usually constructed in a pit in the vicinity of the furnace. The core is rough brick-work covered with layers of clay and horse-dung, turned to shape by a templet. This being dried, a "model" of earth and hair is laid on, being the exact counterpart of the future bell. A third and heavy shell is laid over the model, and when dry is lifted from the model, some *parting* dust having been sprinkled over the model before applying the material of the outer shell. The model is now cut away from the core and the shell replaced, leaving a space between the shell and the core the exact form and size of the bell. The pit being filled around the shell, the metal is run into the mold.

Fig. 637 shows a device for molding bells. The templets or *sweeps* *D D'* each turn on a guide-pin *d*, passing through an opening in the inner and outer cases *A B* respectively, which have lips *a b* around their lower peripheries, serving as guides to the sweeps, and also relieving the loam-mold from pressure when the two cases are brought together.

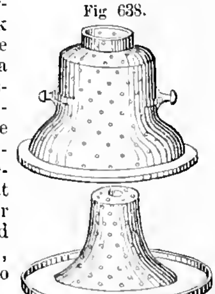
The molds previously described do not afford adequate provision for the escape of confined air and gases, and the casting is liable to be porous. An improved method consists in the employment of perforated metallic flasks corresponding to the interior and exterior surfaces of the bell, and accurately centered to each other by a vertical guide. The outer flask is coated internally, and the inner one externally, with a mixture of loam and combustible matter. The combustible matter is burnt out by the heat of the molten metal, allowing this to shrink, and preventing the occurrence of what is known as a fire-crack or strain; and, the perforated flasks being above ground, free escape is permitted to the gases.

Fig. 637.



Bell-Mold.

Fig 638.



Bell-Flask.

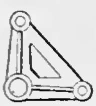
This arrangement is shown in Fig. 638.

2. The mouth of a funnel or trumpet. The *pavillon* (Fr.).

Bell-buoy. (*Nautical.*) One to which a bell is so attached as to be rung by the motion of the waves.

Bell-crank. (*Machinery.*) A rectangular lever having its fulcrum at the apex of the angle, by which the direction of a motion is changed 90°. Its pri-

Fig. 639.



Bell-Crank.

mary application was for ringing bells, hence the name; but it is applicable to many other purposes where a power is to be exerted upon a weight in a direction of 90° from it.

Bell-glass. (*Glass.*) A bell-shaped glass vessel, open at bottom, and having a knob on top for convenience of handling. It is used in connection with an air-pump, by which the air may be exhausted from it; also for holding gases to be experimented upon.

Bell-met'al. An alloy composed of copper and tin, either alone or with the addition of a greater or less proportion of other metals, usually zinc and lead. It is a species of bronze, and from its hardness and sonorousness is better adapted than any other metal for the purpose from which it derives its name. 75 parts copper to 25 tin is a usual proportion, but its constituents vary from 50 copper, 33 zinc, and 17 tin, to 80 copper, 10 tin, 6 zinc, and 4 lead; sometimes the proportions 72 copper, 26.5 tin, and 1.5 iron have been employed. The proportion 78 copper to 22 tin is generally recognized in commerce.

Other approved proportions are given below.

	Copper.	Tin.	Iron.	Zinc.
For Indian gongs . . .	100	20–25		
Church and large bells .	3	1		
House and hand bells . .	2	1		
Paris clock bells . .	72	26½	1½	
Clock bells	72	26		2
Repeating-watch bells .	70	26		4
Overman's	71	26	1	2
Ancient Assyrian bells .	86	14		

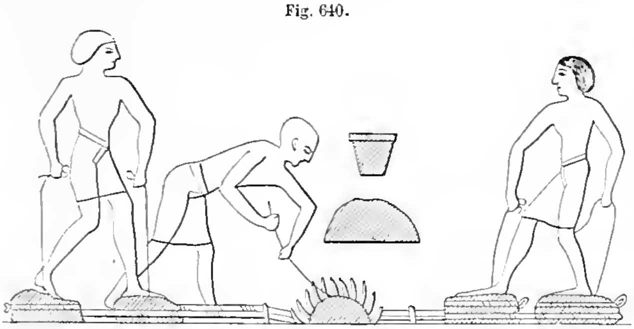
"In some cases two metals were used without alloying; iron, for instance, being overlaid partially or wholly with bronze." — LAYARD.

Bel'lows. (*Pneumatics.*) A device for forcing a stream of air, usually as a means of urging a fire.

Bellows were used in Egypt in the time of Thothmes III., 1490 B. C., and are represented on a tomb bearing the name of that Pharaoh.

A pair of leathern bags or cylinders, attached to disks, were alternately inflated and compressed, during the latter action driving air by a pipe to the fire. The cut is from the tomb referred to, and the

Fig. 640.



Egyptian Bellows (Thebes).

men are shown working the bellows with the feet and hands, throwing the weight on the bags alternately, and lifting with a cord the one which is just exhausted; the other man is holding the rod of metal in the fire. The oldest form of wind-bag was probably the skin of an animal sewed up, or else a wooden reed with a piston like that of a popgun, until tubes were bored out of wood or made of a ring of bark taken from a tree. Our common bellows, consisting of two boards joined by a piece of leather, was early known to the Greeks and Romans. See Fig. 145.

In the *Spiritalia* of Hero, 150 B. C., is described a steam-boiler from which a hot-air blast, or hot air mixed with steam, is blown into the fire, and from which hot water flows, or cold is introduced.

Double foot-bellows, and duplicate pipes to the iron furnace, with four tuyeres, are shown in the paintings of Kourna, Thebes. The blow-pipe and tongs in connection with a smelting-furnace in the same place.

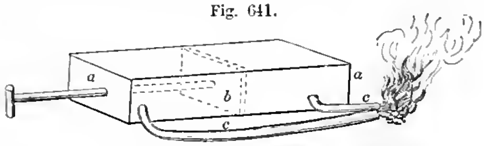
The mention of the burning of the bellows in Jeremiah vi. 29, seems to have been in connection with lead and silver smelting and refining. This is a common combination of metals in ores.

Strabo ascribes the invention of the bellows to Anacharsis the Scythian, who was coëval with Solon. The anchor and the potter's wheel are also ascribed to this man by Pliny, Seneca, and other Romans; the declaration, however, is quite inadmissible as to the potter's wheel, and equally untrue as to both the bellows and the anchor. Homer mentions the potter's wheel, and it was used in Egypt one thousand years before Homer. On the walls of the tombs of ancient Egypt are painted, Ptah, the Creator, and Neph, the Divine Spirit, sitting at the potter's wheel turning clay to form men.

Among the ancient forms of bellows may be cited:

Skins of animals sewed up to form bags, and used in a manner analogous to the bellows of the bagpipe.

Fig. 641.



Japanese Blacksmith's Bellows.

Two such skins used alternately would give a continuous blast: such was the ancient Roman forge-bellows.

A pair of hollow cylinders, made of bamboo or hollow logs, and having pistons actuated by manual power.

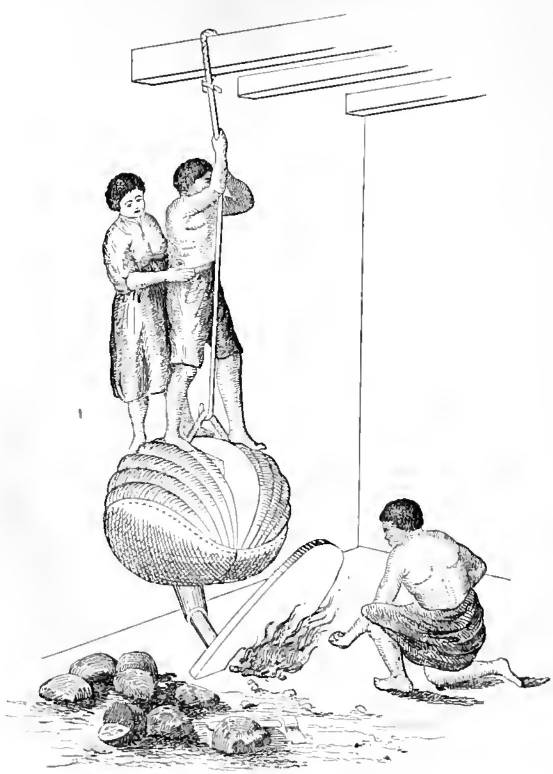
A pair of large calabashes connected by two reeds, and having large openings at the top, covered by tubes of soft goatskin, which are closed down alternately.

A cylindrical bag of soft skin closed at the ends by two wooden disks, by which it was opened and closed like a Chinese lantern. This device in its duplicated form, to render the blast continuous, is still used in Europe and South America.

The Japanese bellows consists of a box *a*, with a reciprocating piston *b*, and two eduction-tubes *c c*, leading from the respective ends of the box to the fire. Our illustration does not indicate the valves in the tubes to prevent reflux of air, nor the air-induction openings. The artist leaves them to be supposed, which is not difficult to do.

The smelting of the ferruginous sand of the Nonkreem Valley, on the confines of English India, is very rudely carried on in charcoal fires blown by double-action bellows, worked by two persons, who stand on the machine, raising the flaps with their hands and expanding them with their feet, as shown in the cut. There is neither furnace nor flux used in the reduction. The fire is kindled on one side of an upright stone (like the head-stone of a grave), with a small arched hole close to the ground; near this

Fig. 642.



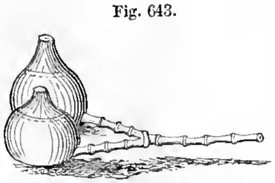
Nonkreem Bellows.

hole the bellows are suspended; bamboo tubes from each of its compartments meet in a larger one, by which the draft is directed under the hole in the stone to the fire.

The ore is run into lumps as large as two fists, with a rugged surface; these lumps are afterward cleft nearly in two to show their purity.

Fig. 643 shows a bellows employed by the Foulah blacksmiths on the west coast of Africa. It consists of two calabashes connected together by two hollow bamboos or reeds inserted into their sides and united at an angle to another which leads to the fire. A large opening is made in the top of each calabash, and a cylindrical bag of soft goatskin stitched or otherwise secured around the edges. The workman seats himself on the ground, and, placing the machine between his legs, grasps the ends of the bags, and by alternately raising each with the mouth open and pushing it into the calabash when closed, the contained air is forced into the tubes and a continuous blast maintained.

Fig. 643.



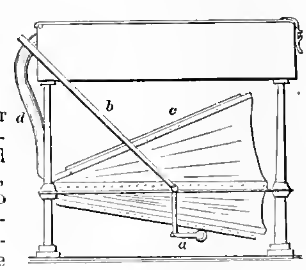
Foulah Bellows.

Wooden bellows were known in Germany in the middle of the sixteenth century, but it is not certain by whom they were invented. Lobsinger of Nuremberg (1550), and Schelhorn of Schmalebuche, in Coburg (1630), are cited as having introduced them.

They are described in a work by Reyner, professor at Kiel, 1669, as being "pneumatic chests," and as consisting essentially of a lid moving in a closely fitting box. In another form we find that two boxes were used, one fitting closely within the other, and the two, being perhaps quadrantal segments of cylinders, were hinged together so that the movable one vibrated on the common axis.

The ordinary bellows in its simplest form consists of two flat boards, usually of triangular shape, each having a projecting handle; and between the boards are two or more hoops bent to the figure of the bellows. A piece of leather is nailed to the edges of the boards, partially infolding the hoops, and forming an inclosed chamber, which is enlarged or contracted by raising the upper board while the lower one remains stationary. The lower board has a metallic pipe attached and a valve in its center, opening upward, which rises when the upper board is raised, admitting air into the chamber, which is expelled through the pipe by depressing the upper board; this arrangement does not afford a continuous blast, the air issuing in puffs, and accordingly the smith's bellows is furnished with a third board, of the same shape as the other two, connected to the lower board by a piece of leather, and dividing the bellows into two similar chambers connected by a valve opening upward; the blast-pipe is connected to the middle board, issuing from the upper chamber. The lower board is held down by a weight, and a weight is also attached to the upper board. In working the bellows the middle board is raised, drawing the air through the valve into the lower cavity, and the descent of the board forces it into the upper cavity, the valves preventing its return, and the weight, depressing the upper board, forces the air out through the pipe in a continuous blast; the ascent of the middle board fills the lower cavity, while its descent fills the upper cavity, the irregular puffing action being confined to the lower cavity of the bellows; the

Fig. 644



Forge-Bellows.

Fig. 645.

Old Roman Lamp.

blast is however, though continuous, not quite regular, as, when the air is forced into the upper cavity, there is an excess of pressure over the pressure during the descending motion of the lower board.

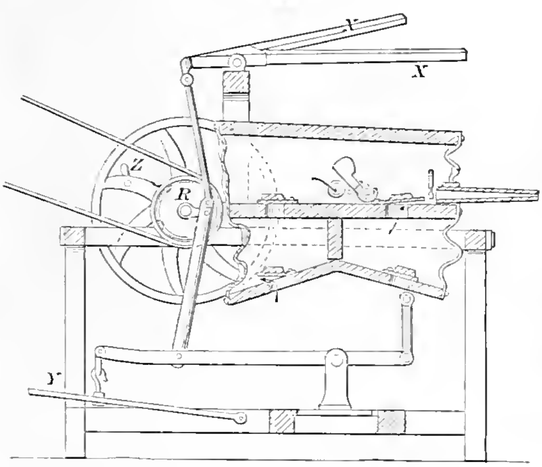
The smith's bellows is worked by means of a rocker with a cord, chain, or rod attached. By drawing down the handle *b* of the rocker the movable board rises, forcing the air through the valve into the upper chamber; the weight on the board *c* forces the air out through the pipe *d* to the fire on the forge-hearth.

Fig. 645, from an ancient Roman lamp, is an exact counterpart of the modern domestic bellows.

Various machine-worked bellows have been invented, but generally those which rise to the dignity of machines lose the pulsative character and have come to be called blowers.

In Fig. 646 the V-shaped bottom is pivoted in the middle, and has a rocking motion imparted by lever

Fig. 646.



Bellows.

X, treadle *Y*, or pulley with fly-wheel *R Z*, either affording a continuous blast. See also BLOWER; BATTERY-FORGE, etc.

A blowing-engine in which the blast of air is supplied by a falling column of water.

Fig. 647.

Bellows-Pump.

Bel′lows-cam′e-ra. (*Photography.*) A form of expanding camera in which the front and after bodies are connected by an expansible portion, like the sides of a bellows or accordeon.

Bel′lows-pump. (*Hydraulics.*) A form of atmospheric pump in which the part of the piston is played by the upper leaf of the bellows. The cut is from Vegetius; Erffurt, 1511.

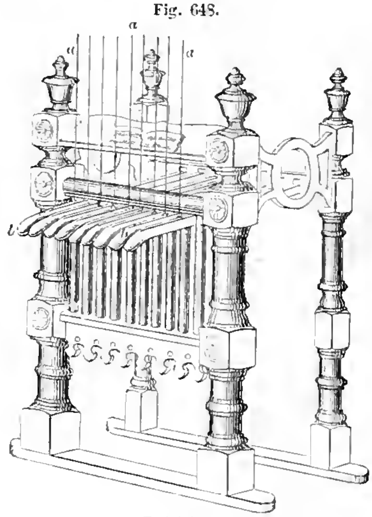
The *bag*-pump and *diaphragm*-pump are other forms.

Bell-pull. The knot and attached cord, or series of wires and bell-crank levers, by which a house-bell is caused to strike.

Bell-ring′er. In England each bell of a chime is provided with a yoke and wheel, and is oscillated in the usual manner, a ringer being required for each bell.

In this country they are usually mounted stationarily, except the tenor, and rung by means of cords

Fig. 648.



Bell-Ringer.

attached to the clappers and led to the ringer's room below, where they are connected, in the order of the notes, with lever-handles *b*, so arranged that the bells may all be chimed by one person. The tenor-bell is provided with mountings for swinging, in order that it may be rung as an ordinary church-bell, and is usually placed in the center of the bell-room, the others being grouped about it in such relative positionsas will most advantageously distribute the weight and allow the best arrangement of the ringing-cords.

Among the devices for the mechanical ringing of bells may be cited steam acting upon a piston to vibrate the clapper; air acting upon vanes to move a pitman connected to the clapper or the axis of the bell; springs released to cause a certain number of pulsations to give a specific alarm set in operation by the touch of a trigger. See CHIME.

Bell-tel′e-graph. A form of apparatus invented by Sir Charles Bright, in which the signals are given by strokes upon two bells of different pitch, one of which represents the movements of the needle to the left and the other to the right.

Bell-trap. (*Pneumatics.*) One form of air or stench trap to prevent the reflux of foul air from drains. It consists of an inverted cup whose edges are submerged in the water of a basin which overflows into the drain. This permits an overflow of water, but prevents a reflux of air. See AIR-TRAP.

Bel'ly. The front or lower surface of an object; as —

(*Railway Engineering.*) The belly of a railway rail; a descending flange between bearings.

(*Music.*) The front of a musical instrument.

(*Engraving.*) The lower edge of a graver.

(*Wheelwrighting.*) The wooden covering of an iron axle.

The rounded surface of an object; as of a bottle, retort, etc.

(*Metallurgy.*) The upper, rounded part of the boshes.

(*Architecture.*) The batter of a wall.

(*Nautical.*) The swell of a sail.

(*Shipwrighting.*) The hollow of a compass-timber; the convexity of the same is the *back*.

(*Machinery.*) A swell on the bottom surface of anything; as, a depending rib beneath a grate-bar, iron beam, or girder, to strengthen it from downward deflection between supports.

(*Saddlery.*) A piece of leather attached to the back of the cantle, and forming a point of attachment in some saddles for valise-straps.

The unburnt side of a slab of cork.

(*Locksmithing.*) The lower edge of a tumbler against which the bit of the key plays.

Bel'ly-band. 1. (*Saddlery.*) The strap which goes beneath the belly and is buckled to the ends of the back-band, completing the girth.

2. (*Nautical.*) A strengthening strip of canvas half-way between the close-reef and the foot.

Bel'ly-brace. (*Steam-Engine.*) A cross-brace stayed to the boiler between the frames of a locomotive.

Bel'ly-rail. (*Railroad Engineering.*) A railroad rail with a fin or web descending between the portions which rest on the ties. It is seen in the improved Penrhyn rail, 1805; also in Stephenson and Losh's Patent, 1816.

Bel'ly-roll. (*Agriculture.*) A roller with a protuberant midlength, to roll the sloping sides of adjacent lands or ridges.

Belt. 1. (*Machinery.*) A strap or flexible band to communicate motion from one wheel, drum, or roller, to another. Belts are made of leather, gutta percha, caoutchouc, wire, woven fabric, and other materials.

Two leathern belts have lately been made in Pawtucket, composed of two thicknesses of leather firmly cemented together, without a stitch, rivet, or peg in either of them, and are half an inch thick. The larger of the two was made from 54 large ox-hides, is 136 feet long, 48 inches wide, and weighs 1,000 pounds. The other is 87 feet long, 36 inches wide, and weighs 475 pounds.

The ratio of friction to pressure for belts over wood drums is, for leathern belts, when worn, .47; when new, .5; and when over turned cast-iron pulleys, .24 and .27.

A leathern belt will resist a strain of 350 pounds per square inch of section, and a section of .2 of a square inch will transmit the equivalent of a horse-power at a velocity of 1,000 feet per minute over a wooden drum, and .4 of a square inch over a turned cast-iron pulley.

A vulcanized india-rubber belt will sustain a greater stress than leather, added to which its resistance to slipping is from 50 to 85 per cent greater.

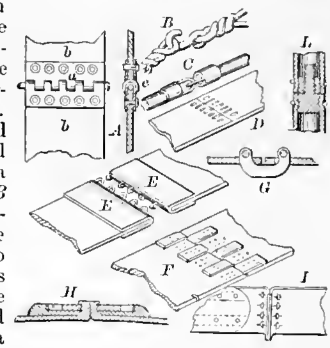
2. (*Masonry.*) A range or course of stones or bricks projecting from the rest, either plain or fluted.

Belt-clasp. (*Joint.*) A device for attaching the ends of belting together so as to form a continuous band. See BELT-COUPLING.

Belt-coup'ling. (*Machinery.*) A device for joining together the ends of one or more bands or belts. This is commonly effected by cutting or punching holes near the two extremities to be joined, and lacing them together by thongs of lacing-leather or calfskin. Many special devices have been contrived to dispense with lacing, for which see also BUCKLE.

In the figure, *A* represents a coupling in which the ends of the belt *b* are secured by eyelets or rivets between bent metallic straps *a*, which form leaves of a hinge *c*. A pintle passes through the eye of each portion of the hinge.

Fig. 649.



Belt-Coupling.

For the round belts of foot and hand lathes, a figure-8 hook *B* is used for a coupling, or a couple of sockets *C*, into which the ends of the belt are inserted, and which have a hook and eye respectively.

For flat belts in which lacing is not deemed advisable, the ends may be joined by hooks inserted from alternate sides and hammered flat as at *D*.

Other modes of coupling-belts are to be found; some involving hooks *E*, and others lapping-plates *F*. Other forms approach the buckle and various peculiar interlacing devices, such as curved bars of metal *G*, slotted plate and toggle-jaws *H*, or rivets which pass through the out-turned end of the belt, as at *I*.

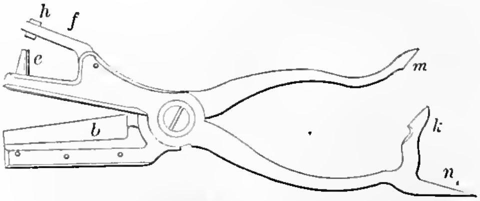
L is a tie in which a plug with two grooves is made the means of connection; the belt is tubular, and the respective ends are throttled by wires into the grooves of the plug.

Belt-cut'ter. *a.* A machine or tool for slitting tanned hides into strips for belting. In a machine for this purpose the knives are set at gaged distances apart, or the knife at a gaged distance from the governing edge, and the leather passed along below the knife, or conversely.

b. A tool for this purpose has a fence which runs along the governing edge, and a cutter adjustable to the required distance, equal to the width of the strip desired. Such tools are used by harness-makers for cutting out lines and straps for harness. See GAGE-KNIFE.

c. An implement for preparing belts for being laced

Fig. 650.



Belt-Cutter.

or coupled. That shown combines a cutting-blade *b*, punch *c*, awl *n*, and pliers *k m*.

Belt'ing. (*Machinery.*) A flexible band for communicating motion. See BELT.

Belts are made of leather, india-rubber, gutta-percha, hempen rope, webbing, etc.

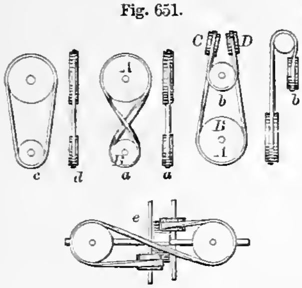
A belt is said to be *quartered* when it passes around pulleys whose axes are at right angles to each other, as at *b*.

Belts crossed so as to run the pulleys in opposite directions are said to be *crossed* or *halved* (*a*, Fig. 651).

A *band* is a flat belt.

c d (Fig. 651) are respectively side and end elevations of a driving and driven pulley, moving in the same direction, the relative speed being proportionate to their respective radii.

Fig. 651.



Drums and Belts.

a shows the belt crossed, causing the driven pulley *B* to move in a direction opposite to that of the driver *A*.

In *b b* two pulleys *C* and *D*, driven immediately from *A*, are caused to rotate in reverse directions by means of a guide-pulley *B*, under which the band passes.

e shows a mode of driving two pulleys from a single driver by one belt.

India-rubber belting is prepared by folding rubber cloth to a sufficient thickness and desired width. The folded stuff is then placed in a *flat-press*, and subjected to a steam-heat of 280° Fahr. to vulcanize the rubber and blend all the plies into one.

Artificial-leather belting is made of leather scraps and shavings washed in alkaline water, pulped with gelatinous and resinous substances, vegetable fiber, and bullock's blood.

When properly pulped, the same may be run off on an ordinary paper-machine or between rollers, and doubled to a proper thickness, and may be used either with or without farther preparation by japanning, stitching, or water-proof applications. The belting is usually subjected to a high temperature of heat, to set the gluten and other resinous properties.

A form of belting called *angular belting* has been lately introduced, which has riveted on the working side of the continuous plies of the belt a series of rectangular truncated pyramids of leather. The sides of the pyramidal frustums have an angle of about 60° with the belt in the example at the American Institute Fair, 1872; but this would probably vary with the diameter of the pulley over which these *belt-shoes* were designed to be lapped.

Leather belting is ordinarily prepared in the following manner: both oak and hemlock bark are used in tanning, but oak-tanned leather is decidedly superior, and commands a higher price in the market.

Slaughter hides are limed and bated in the usual way, closely trimmed and green shaved, after having been well washed in the washing-wheel, and when the hair has been removed they are put into the tan liquor, being tacked to laths which rest upon ledges along the sides of the vat.

After the tanning process has been completed, each hide is split into four pieces, of which the middle piece, comprising the back, is for heavy belting. These pieces are now put into the barrel-washer, and, after a few revolutions, for the purpose of cleaning them, they are passed between two iron cloth-covered rollers, constructed similarly to a clothes-wringer, by which they are pressed dry enough to receive the stuffing, the work being done by hand; the pieces are then hung up to dry.

When the stuffing has had time to dry in sufficiently, each piece is thoroughly dampened and then passed through a powerful lever-stretching machine, where it may be subjected to a strain of sixty tons to the piece, after which it is oiled and hung up to dry. The effect of this stretching is to make it almost impossible for the belt to stretch by ordinary use after completion.

These pieces, after becoming thoroughly dry, are passed to the belt-room, where are machines for planing off the laps, joining the different parts, and straightening the edges. After the riveting, the edges are pared or rounded, and for this purpose the belt is passed between two paring-bits, which are set one on each side of a groove the width of the belt. As the belt is drawn along the edges are rounded, the belt being wound around an arbor. If a square edge is required, the coil is simply taken from the arbor, scraped with a slicker, and burnished until it has a glazed appearance.

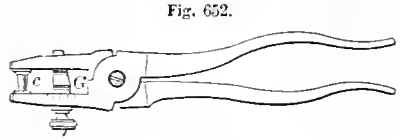
Belt-lac'ing. Leather thongs for lacing together the adjacent ends of a belt to make it continuous.

Machines for cutting narrow strips of leather for lacing operate by means of a gang of circular knives, which split into strips the leather which passes against them. The knives are secured by collars on a mandrel, at gaged distances apart, and their edges cut against a parallel roller set over against the former at such distance as may suffice to allow the leather to pass in the interval. Another form of the machine is a gang of stationary knives which cut the side or strip of leather which is drawn against and between them by means of rollers.

Belt-pipe. (*Steam-Engine.*) A steam-pipe which surrounds the cylinder.

Belt-punch. A punch for forming the holes in a belt into which lacing, rivets, or clasps are inserted. The punch *c* acts against an anvil on the other jaw,

Fig. 652.



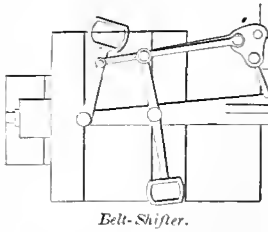
Belt-Punch.

the latter is graduated, and has an adjustable gage *G*, which may be set at such a distance from the nose of the pliers that a row of holes may be readily punched at a set distance from the edge of the belt.

Belt-saw. A Band-saw (which see).

Belt-shift'er. (*Machinery.*) A device for shifting a belt from a fast to a loose pulley, or *vice versa*, or from one pulley to another, to cause a change in the motion of the belt, or to shift the power of the belt to another pulley running in the same direction. In the illustration, the pivoted levers connected by jointed rods with the rocking-bar simultaneously shift the belts.

Fig. 653.



Belt-Shifter.

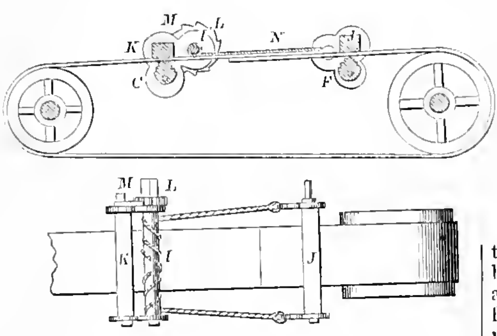
Belt-speed'er. (*Machinery.*) A pair of cone-pulleys carrying a belt which, by shifting, become the medium of transmitting varying rates of motion. It is much used in some spinning-machines to vary the rate of rotation of the spool as the cap increases in size. See Cone-pulley.

Belt-splic'ing. (*Machinery.*) A mode of fastening ends of belts or belt-lengths, by splitting one end so as to hold the long tapered edge of the other one, which is cemented between the lips of the former.

Belt-stretch'er. A device for drawing together the ends of a belt, in order that they may be sewed or riveted to render the belt continuous.

The belt is placed around a couple of pulleys, and its ends approached to lap upon each other for sewing. The stretcher consists of a pair of clamps *K C*, *J F*, and a tightening-cord *N*, the leather in each clamp being pinched by a serrated eccentric. The rope winds upon the roller *I*, the pawl *M* engaging the ratchet *L* to maintain the stretch.

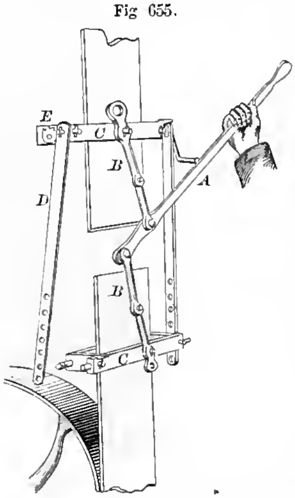
Fig. 654.



Belt-Stretcher.

Belt-tight'en-er. Fig. 655 shows a double clamp and a tightening-device, in which *A* represents a lever acting through toggles *B* to draw the clamps *C* towards each other. When they are drawn as nearly together as may be requisite, they are held by the bars or link *D* until the belt is laced or riveted.

Fig 655.



Belt-Tightener.

Another form of belt-tightener is a device to rest against the belt in some part of its length between two drums over which it runs, so as to increase its frictional adherence to the drums. The device is usually an idler-pulley on a swinging frame or weighted.

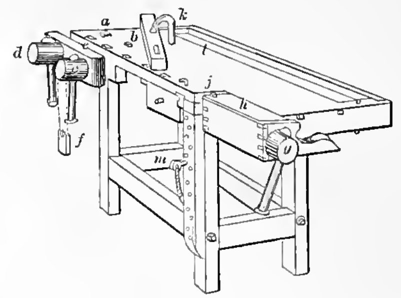
Belt-weav'ing Loom. One for weaving heavy narrow stuff suitable for making belts for machinery. It does not differ in any substantial respect from a narrow-ware loom, as belting only differs from webbing in proportions or material, if at all.

Bench. 1. (*Engineering.*) A horizontal ledge on the side of a cutting, an embankment, or parapet. A *berme ;* a *banquette.*

2. A support for tools and work in various mechanical operations, as carpentry, metal and leather working, etc.

The bench is of a thick plank, or, better still, a number of pieces of scantling glued and bolted together, — a combination which resists warping better than any mere plank, however thick or well braced. At the back part is a shallow trough *l* to hold small tools. *a b* are, respectively, a toothed and a square bench-hook, which slip in vertical mortises so as to assume any required elevation, or be driven down flush with the surface of the bench. *k* is a holdfast, which clamps work to the bench.

Fig 656.



Carpenter's Bench.

d e are the screws of a bench-vise *e*, by which work is held. The screw *d* has a garter *f*, which enters a notch in the cylindrical neck of the screw, keying it in the jaw, so that the latter follows the inward and outward motions of the screw. A number of stops are placed along the front of the bench, either of which may be raised to hold one end of a piece of work, while the other end is held by the stop *j* on the sliding-piece *h*, which is moved by the end-screw *g*.

When a board is placed edgeways in the vise *e*, its bottom edge may rest on a pin *m*, which is placed in either one of the vertical series of holes in the post.

Bench-clamp. A jaw-tool attached to a work-bench for holding an article to be operated on in place.

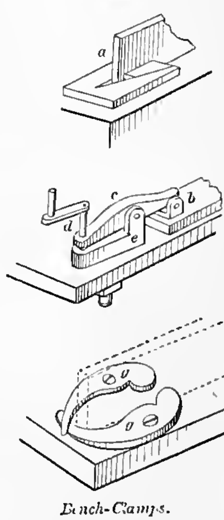
The bench-clamp is shown on a painting in Herculaneum, where it is used to dog a timber to a bench while it is being sawed by a frame-saw.

In one form, *a*, the board, when set on edge, is clamped by two wedges between the angular cheeks.

In another, the clamp *b* has an arm *c*, which is pressed downward upon the work to be held by means of the screw *d*, whose end rests on the base-piece of the clamp *e*.

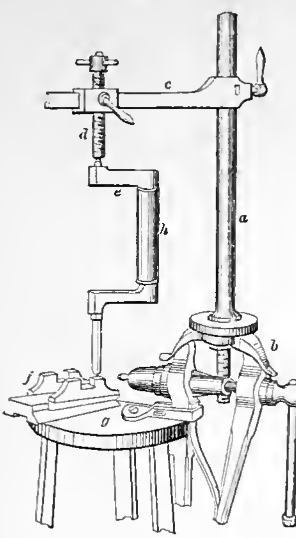
Another clamp is formed of two pivoted dogs *g g*, between whose heads the board slips. The board is shown in dotted lines, and pressure against the tails of the dogs clamps their heads against the sides of the board.

Fig. 657.



Bench-Clamps.

Fig. 658.



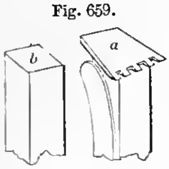
Bench-Drill.

Bench - drill. A drill adapted to be used on a machinist's or carpenter's bench. In the example shown, a post *a* is erected between the jaws of the bench-vise *b*, and has a vertically adjustable arm *c*, in which is the feed-screw *d*, which forms the pintle or *back-center* of the brace *e*. The work *f* is placed on the bench *g*, and the brace is rotated by the hand, which grasps the loose sleeve *h*.

Bench-ham'-mer. (*Metal-working.*) A finisher's or blacksmith's hammer. They are of various sizes and shapes for different kinds of work.

Bench-hook. A stop or abutment which occupies a vertical mortise in a carpenter's bench, and is adjustable to any required elevation, to stay the wood being planed ; or may be driven flush with the surface of the bench when its services are not needed.

Fig. 659.

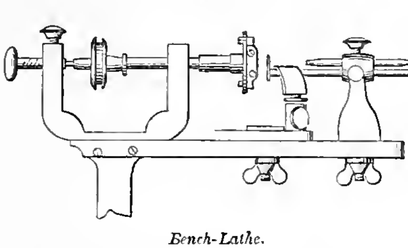


Bench-Hooks.

One of the hooks *a* has a notched plate against which the wood is driven in planing ; the other hook *b* is square, so as not to damage nearly finished work.

Bench-lathe. A small lathe such as may be mounted on a post which stands in a socket in a

Fig. 660



Bench-Lathe.

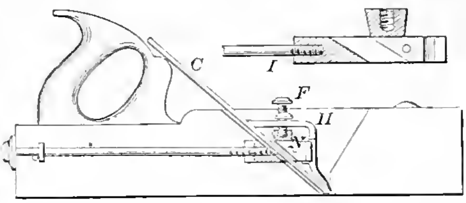
bench. In the illustration, the mandrel carries a face-plate with centering devices, and may be driven by a cord from a treadle or by a bow. The tail-stock and rest are adjustable by thumb-nuts.

Bench-mark. (*Surveying.*) A mark showing the starting-point in leveling along a line ; also similar marks affixed at convenient distances to substantial or permanent objects, to show the exact points upon which the leveling-staffs were placed when the various levels were read, thus facilitating reference and correction.

Bench-plane. A joiner's plane for working a flat surface. They are named, in the order of their fineness, *jack, long, trying panel, smooth, jointer* planes (which see).

It consists of a stock traversed by a slot in which is wedged a slanting knife, sharpened at its lower edge, and called the plane-bit. The opening in the *sole* through which the *bit* protrudes is called the throat. The degree of protrusion of the bit determines the rankness of the cut and the consequent thickness of the shaving. The bit is usually held

Fig. 661.



Bench-Plane.

by a wedge driven in from above, but clamping arrangements have been suggested, though they are not in much favor. In the one shown, the cap-piece is held against the bit by means of a screw *I* passing from the heel of the plane to the nut *N* in contact with the cap *H* and bit *C*, and a second screw *F*, which pushes down the nut in the cap-piece.

Bench-reel. A spinning-wheel on the pirn of which the sailmaker winds the yarn.

Bench-screw. (*Carpentry.*) The wooden screw which operates the movable jaw of the joiner's bench-vise. See BENCH.

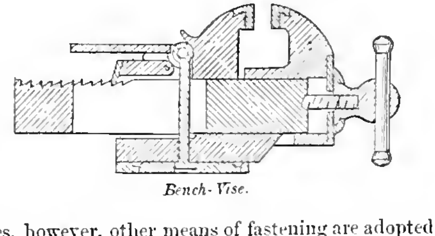
Bench-shears. Hand-shears, the end of whose lower limb is turned at right angles and is received in a socket in the bench.

Bench-strip. (*Carpentry.*) A batten or strip on a carpenter's bench which may be fixed at a given distance from the edge to assist in steadying the work. It may form a fence or a guide.

Bench-vise. A vise provided with means for attachment to a wood or metal worker's bench. In the vise of the carpenter's bench the movable wooden jaw is clamped against the stationary jaw of the bench by means of a wooden screw rotated by a lever occupying a slot in the head.

In the ordinary metal-worker's vise the jaws are both of iron, and one of them has a spreading claw which is screwed fast to the bench. In parallel

Fig. 662.



Bench-Vise.

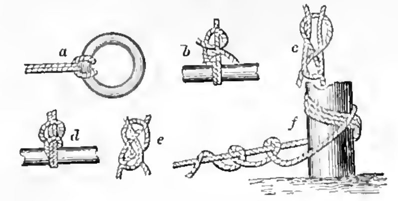
vises, however, other means of fastening are adopted. (See VISE.) In the illustration, one jaw slips on the bar as the nut is rotated by the handle ; the other jaw is fixed in the required position on the said bar by means of a pawl.

Bend. 1. (*Shipwrighting.*) *a.* One of the strong planks or *wales* on a vessel's sides to which the beams, knees, and futtocks are bolted. See WALE.

b. The cross-section of a building-draft. A *bend* represents the molding edge of a *frame.*

2. (*Mining.*) An indurated argillaceous substance.
3. (*Nautical.*) A knot by which one rope is fastened to another, or to an object such as a ring, spar, or post.

Fig. 663.



Bends.

a, a *loop*-bend. *d*, a *rolling* bend.
b, a *fisherman's* bend. *e*, a *carrick* bend.
c, a *common* bend.
f, a *mooring*-bend, in which the rope is bent to a post or *bollard* on a pier or wharf.

Bend'ing. A process applied to plates to form them into cylindrical shapes, or angular shapes for boilers, angle-iron, etc.

When the material is brought to a corrugated form it is termed CORRUGATING (which see).

The bending of wood for thills, bows, fellies, plow-handles, etc., is usually while steam-hot, and supported in clamps and formers.

Angle-iron for ships' frames is bent to give the proper figure to the molding edge, by means of a *leveling-block* or by a *swage*. The former is adapted to produce sharp curvatures. See LEVELING-BLOCK.

The *swage* consists of a fixed curved bed and a reciprocating block. One side of the bar to be bent or straightened rests against a pair of fixed blocks, with slightly rounded surfaces. Midway between those fixed blocks the opposite side of the bar is pressed against by a block having a reciprocating motion. The position of the fixed blocks and the length of the stroke of the movable block are capable of adjustment, according to the alteration to be produced in the figure of the bars.

Bending of plates for ships' sides is performed by passing them between a pair of bed-rollers and a free roller above, whose bearings are adjustable by means of screws so as to give any required curvature to the plate.

Boiler-plates are bent in the same way.

Bend'ing-strake. (*Shipwrighting.*) Two strakes wrought near the coverings of the deck, worked all fore and aft a little thicker than the rest of the deck, and let down between the beams and ledges so that the upper side is even with the rest.

Bend-leath'er. A superior quality of sole-leather.

Ben-gal'. (*Fabric.*) *a.* A thin, light Bengalee stuff, made of silk and hair, for women's apparel.

b. An imitation of striped muslin. (*Bengal-stripes.*)

Ben-gal'-light. (*Pyrotechnics.*) A kind of firework, giving a vivid and sustained blue light, used as a signal; also written *Bengola.*

The composition for Bengal-lights is, 1 part antimony, 2 sulphur, 2 mealed powder, and 8 nitrate of soda. These are finely pulverized and thoroughly incorporated together, and the composition is pressed into earthen bowls or similar shallow vessels. When not used immediately, the mouth should be covered with waxed paper to exclude moisture.

Ben-gal'-stripes. (*Fabric.*) A Bengalee striped cotton cloth.

Bent. One section of the frame of a building, which is put together on the ground or foundation, and then raised by holding the feet of the posts and elevating the upper portion. A bent consists of posts united by the beams which pass transversely across the building. When raised, it is secured by the beams of the side to the other bents.

Bent-gage. (*Wood-working, etc.*) One whose blade forms an angle with the handle. Used by wood-workers and sculptors.

Bent-gouge. (*Wood-working.*) A gouge bent towards the basil, and used for scooping or hollowing out concave surfaces. A *bent-neck gouge.*

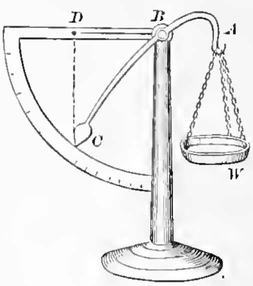
Bent-gra'ver. 1. (*Jewelry.*) A *scorper.*

2. (*Engraving.*) A graver with a blade so bent as to reach a surface whose plane is lower than a marginal rim. Used in chasing and in engraving monograms in sunken tablets.

Bent-le'ver. A lever the two arms of which form an angle at whose apex is the fulcrum; as, a bell-crank lever.

Bent-le'ver Bal'ance. A weighing-scale in which the scale-pan *W* is attached to the short end *A* of a bent-lever, which is pivoted on the summit of a post *B*, and whose weighted end *C* traverses a graduated arc to a distance proportioned to the weight in the pan *W*. As the weight *C* ascends, its leverage becomes greater, and it balances a correspondingly greater weight in the pan *W*. Its leverage in the position shown is indicated by the vertical dotted line dropped from *D*.

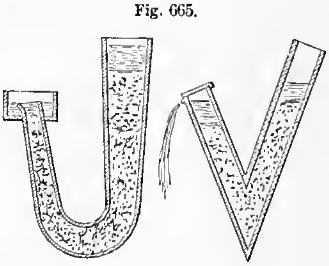
Fig. 664.



Bent-Lever Balance.

Bent-pipe Fil'ter. A tube whose bend forms a containing receptacle for a certain quantity of sand through which water passes, entering at one leg and being discharged at the other.

Fig. 665.



Bent-Pipe Filter.

Bent-rasp. One having a curved blade. Used by gun-stockers and sculptors.

Ben'zole. Discovered by Faraday in oils in 1825, and by C. B. Mansfield in coal-tar, 1849. The latter was fatally burned while experimenting with it in 1855. Aniline is produced from it, and is the source of the celebrated modern dyes, mauve, magenta, etc.

Ber'ga-mot. (*Fabric.*) A coarse tapestry, said to have been first made at Bergamo, Italy. It is composed of flocks of wool, hair, silk, cotton, or hemp.

Ber'lin. (*Vehicle.*) A species of four-wheeled carriage having a sheltered seat behind the body and separate from it. Introduced previous to 1673 by Philip de Chiese, of Piedmont, in the service of William, Elector of Brandenburgh

Berme. 1. (*Fortification.*) A narrow, level space at the foot of the exterior slope of a parapet, to keep the crumbling of the parapet from falling into the ditch. See ABATTIS.

2. (*Engineering.*) A ledge or bench on the side

or at the foot of a bank, parapet, or cutting, to catch earth that may roll down the slope or to strengthen the bank.

In canals, it is a ledge on the opposite side to the tow-path, at the foot of a talus or slope, to keep earth which may roll down the bank from falling into the water.

Slopes in successive benches have a berme at each notch, or, when a change of slope occurs, on reaching a different soil.

Berth. A sleeping-space of limited dimensions on board ship or on a railway-car. It consists of a box or shelf, usually permanent on shipboard, occupying a space against the wall of a state-room or cabin.

In railway-cars berths are usually made at two elevations; the lower one is made up by bridging the space between two adjacent seats, the upper berth by letting down a shelf from above. See SLEEPING-CAR.

Berth and Space. (*Shipwrighting.*) The distance between the molding-edge of one bent or frame of a ship to the molding of another bent or frame. Same as *room and space.*

Bes'se-mer Pro'cess. A metallurgic process which serves as a substitute for puddling with certain descriptions of cast-iron, and for the manufacture of iron or steely-iron for many purposes.

Steel is a compound of iron and carbon, standing in the series between wrought-iron and cast-iron, the former having less carbon, and the latter more, than steel. An old authority gives the contents of carbon in different classes as follows: —

Pure refined iron contains	0.00	per cent.
Soft cast-steel "	0.83	"
Common cast-steel "	1.00	"
Harder cast-steel "	3.33	"
White cast-iron "	4.00	"
Mottled cast-iron "	5.00	"
Black cast-iron "	8.00	"

The old-fashioned way of manufacturing the so-called *blister* steel was to first produce a refined iron, and then cause the bars to re-absorb the necessary quantity of carbon in the cementation furnace, where they were treated, imbedded in charcoal for at least a fortnight. This steel broken up and remelted in crucibles forms *cast*-steel. The refining of iron in a puddling-furnace to the point where it assumed the character of steel was the next step in the process. See STEEL.

Mr. Bessemer's process is as follows: —

The iron which is to be converted into steel is melted in cupola furnaces, and tapped off into a large ladle standing upon scales, where the weight of the charge may be accurately determined. When everything is ready, the charge, of about twelve thousand pounds, is run into one of the "convertors." This is an egg-shaped iron vessel, about fifteen feet high and nine feet diameter, hung by trunnions upon a ponderous iron framework. To one trunnion is attached a heavy pinion, worked by a rack, driven by a water-engine, which rotates the vessel in a vertical plane. Through the other trunnion, which is hollow, passes an air-pipe, which is continued down the outside of the vessel, and opens into a chamber at the bottom of the "convertor." (See CONVERTOR.) This chamber communicates with the main cavity of the vessel through 120 holes, each three eighths of an inch in diameter. These holes are contained in ten cylindrical fire-bricks, imbedded in refractory materials, and the whole bottom — chamber and all — is removable at pleasure. The main cavity is lined a foot thick with a mixture of crushed quartz, sand, and clay, and opens at the top obliquely upward through a "nose" pointing towards the chimney. It is evident that the blast must pass through a trunnion, because the vessel could not be rotated if received in any other manner. Prior to receiving the charge, the lining is heated nearly to whiteness, and the vessel is inclined to a horizontal position, or beyond, in order to keep the air-holes above the fluid iron while charging. The blast is then turned on, the vessel righted, and the pressure of the blast keeps the metal from pouring through the air-holes. Immediately the reactions commence.

The cast-iron used in the convertor contains about two per cent of silicon, which has a powerful affinity for oxygen, and the combustion of which generates enormous heat. When the carbon oxidizes, which it does in the later stage of the conversion, a long body of flame issues from the convertor of a dazzling whiteness. It is so brilliant that the eye can scarcely endure it, and with the heavy roar of the blast, the rumbling from the volcanic turmoil within, and the showers of sparks blown out of the vessel in thousands of scintillating pellets, forms a scene which must be witnessed in order to be appreciated.

The completion of the blow and the exhaustion of the impurities is denoted almost instantaneously by a change in the whiteness of the flame to a hollow, lurid, translucent glare, accompanied with smoke. The change occupies scarcely three seconds, and great care must be taken to turn down the vessel the moment the conversion is complete. The product contained in the convertor is nearly pure iron, in a state of perfect fluidity. A small quantity of oxide of iron is mechanically mingled with it, which must be removed, and for this purpose five or six per cent of spiegeleisen is run into the vessel. The manganese of this metal at once decomposes the oxide of iron, takes up its oxygen, freeing the iron, and passes into the slag an oxide of manganese. The carbon of the spiegeleisen is partly oxidized and partly remains in the iron, giving it its steel properties. After waiting a few seconds for this reaction to complete itself, the vessel is rotated farther down, and its contents discharged through the nose into the ladle wielded by a huge hydraulic crane, and then poured through a hole in the bottom of the ladle into iron ingot-molds. The blowing occupies about twenty minutes, and the loss of metal is about thirteen per cent.

The rotation of the convertor, which, together with its charge, weighs over thirty tons, the shifting of the ingot-molds, ladles, and other parts, and the removal of the ingots, are all effected by hydraulic power. The American form of the apparatus is the work of Mr. Holley, and is a total renovation of the English method and a great improvement.

HOLLEY'S convertor has a joint below the trunnions, and the lower portion of the bulb may be taken off, placed on a car, and wheeled away, so that the workmen may be able to get directly at the tuyeres, and can set them quickly and strongly by ramming *ganister* solidly around them, instead of pouring it around them in a semi-fluid state, as in the cases where the bottom of the convertor is reached through the mouth. By having some supplementary bottom-sections to replace at once those in which the tuyeres have become burned out or worn too short, the daily working capacity is about doubled.

The ingots are highly crystalline, and generally contain many cavities, which, however, have not been exposed to the air, and therefore close together perfectly under hammer or in the rolls. The weight of the ingot is about 1,400 pounds, and it will make two railway bars. It cannot usually be hammered until after it has been cooled and reheated. It averages a foot square, is three or three and a half feet high, and has considerable taper. In order to enter a 23-inch train of rolls, it must be "bloomed" down to about six inches, and for this purpose it is reheated to full orange redness, hammered, and cut in two. It is reheated a second time for rolling, and each "bloom" receives 17 passes, issuing from the last one over 30 feet in length. The ragged ends are sawed off by two saws, placed 28 feet 5 inches apart, and when cool the bar is just 28 feet long, having contracted 5 inches, and weighs usually 67 pounds to the yard, — more or less, of course, according to the pattern.

Best-work. (*Mining.*) A miner's term of the best or richest class of ore.

Bé-ton′. Specifically, the French term for concrete; a concrete, the invention of M. Coignet, composed usually of sand 5, lime 1, hydraulic cement .25. The materials are mixed by a shovel, ground violently in a tempering-mill, water being added sparingly from time to time. The pug-mill has a vertical cylinder and a shaft armed with knives spirally arranged, beneath which is a cycloidal presser which drives the plastic béton out at holes in the bottom of the mill. This is carefully and persistently rammed in molds, a stratum at a time, till the mold is full. The top of each stratum is deeply scratched to bind its successor thereto. The molds are coffers *in situ*, or ordinary molds, according to circumstances. The reduction by ramming is very great, about 1.7 to 1. The weight becomes 140 pounds to the cubic foot. The resistance to crushing is 5,000 pounds to the square inch; ten times that of a common mortar made of the same materials and proportions.

Sewers made on this plan may have the centering removed in eight hours, and in four or five days they may be used. Arches with a pitch of 1 in 10 have proportions, sand 5, lime 1, hydraulic cement, .5. In Paris, arches, floors, foundations, barracks, and churches are made of this material. A dwelling of five stories, in Miromesnil Street, Paris, is constructed of a single mass of béton; a staircase of the same material runs in helicoidal form from the basement to the highest floor, molded in the position where it stands.

In making foundations of blocks of hydraulic concrete, sheet piling is first driven, and forms a wall or curb to maintain the concrete in place until *set*.

This is an old Roman method, and was described by Vitruvius. It has also been used by the French in their works in Algiers. Blocks of 324 cubic feet were floated out and dropped from slings into their places.

English recipe: —

Puzzuolana	12
Quicklime	9
Sand	6
Stone spalls	9
Iron scales	3

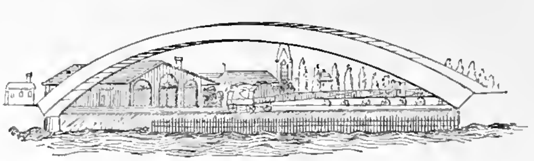
Molded or mixed in a box.

M. Coignet erected a test arch at St. Denis, near Paris, whose dimensions are as follows: —

Span	196 feet.
Rise of arch	19 "
Cross-section at the crown	4 feet by 3.25 "
Cross-section at the springing	6.5 feet by 6.5 "
Specific gravity of the material	2.200
Weight of arch	260 tons.

The arch was constructed in six days, being formed in thin concentric layers. After it had reached what was deemed a sufficient size, it was allowed to remain for five or six weeks, at the end of which time all

Fig. 666.



Béton Bridge.

extraneous supports were removed. This was several years ago, and it yet stands uninjured, and promises to remain an enduring monument of the skill of its constructor. The total amount of depression sustained by the center of the arch after the centering had been removed was barely three eighths of an inch.

Bet′ty. (*Slang.*) A short crowbar; a jemmy.

Be-tweens′. A grade of needles between *sharps* and *blunts*.

Bev′el. 1. Any angle except one of 90°.

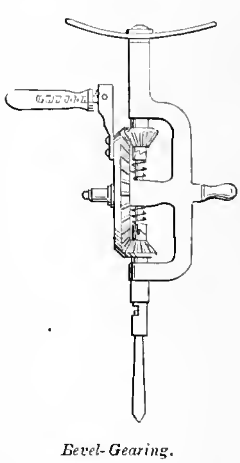
2. An instrument for setting off any angle or bevel from a straight line or surface, much used by artificers of all descriptions for adjusting the abutting surfaces of work to the same inclination. It is composed of two jointed arms, one of which is brought up square against the line or surface from which the angle is to be set off, and the other then adjusted to the desired bevel or inclination. See BEVEL-SQUARE.

3. (*Printing.*) A slug cast nearly type-high and with chamfered edges. Used by stereotypers.

4. The obliquity of the edge of a saw-tooth across the face of the blade.

Bev′el-gear′ing. (*Gear.*) Cogged wheels whose axes form an angle with each other, the faces of the cogs being oblique with their shafts, the sum of the angles of the teeth with their respective shafts being equal to 90°. The illustration shows a breast-drill in which a bevel-wheel drives two bevel-pinions on the stock of the drill; one pinion is for cutting, the other for feed.

Fig. 667.



Bevel-Gearing.

Bev′el-ing. 1. (*Carpentry.*) The sloping of an arris, removing the square edge.

2. (*Shipwrighting.*) *a.* The opening and closing of angle-iron frames in order to meet the plates which form the *skin* of the ship, so that the *faying* surface of the *side-arm* of the angle-iron may exactly correspond to the shape of the plating.

The beveling is performed by smiths while the iron is lying hot upon the leveling-block.

b. The angles which the sides and edges of each piece of the frame make with each other.

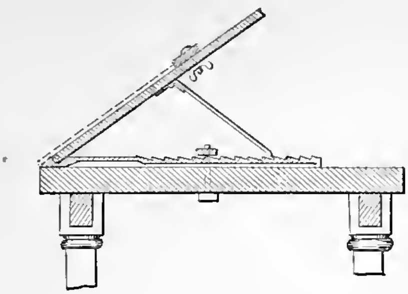
A *standing* beveling is made on the outside; an *under* beveling is one on an inner surface of a frame of timber.

Bev′el-ing-board. (*Shipbuilding.*) A flat piece of wood on which the bevelings of the several pieces of a ship's structure are marked.

Bev′el-ing-edge. (*Shipbuilding.*) One edge of a ship's frame which is in contact with the skin, and which is worked from the *molding-edge* or that which is represented in the draft.

Bev'el-ing-ma-chine'. (*Bookbinding.*) A machine in which the edge of a board or book-cover is beveled. The table on which the material is laid is hinged to the bed-piece, and may be supported at any desired angle by the pawl-brace and a rack, so as to present the material at any inclination to the knife.

Fig. 668.

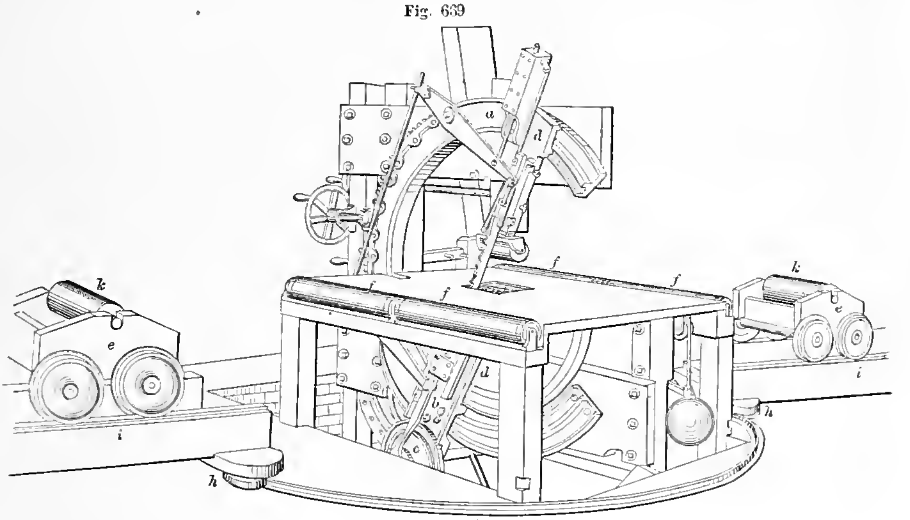


Beveling-Machine.

Bev'el Plumb-rule. (*Engineering.*) A surveyor's instrument for adjusting the slope of embankments.

Bev'el Scroll-saw. A machine for sawing ship-timber to the proper curve and bevel. The saw is mounted on a circular frame *a*, and reciprocated by means of a rod *b* and eccentric *c*. By inclining the saw in its frame any required bevel may be cut, the curve being given by moving the carriage *d d* on its circular track *a*, so as to vary the presentation of the timber. The timbers rest on the rollers *f f* of the table; but if long, are likewise supported by the rollers *k k* of the carriages *e e*, which run towards and from the saw on tracks *i i*. To change the presentation for oblique or circular cut, the carriages *i i* move in concert — if the timber be long enough to bring them both into action — around the track *g*, against whose flange the guide-rollers *h h* bear.

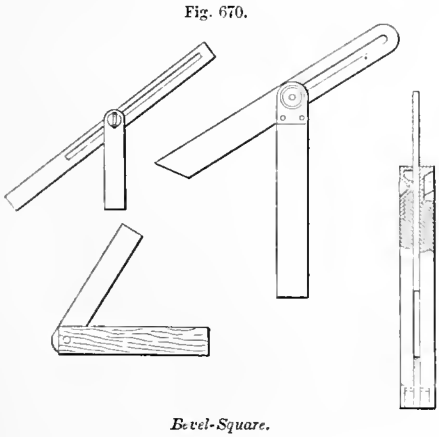
Fig. 669



Bevel Scroll-Saw.

Bev'el-square. One whose blade is adjustable to any angle in the stock, and retained at any *set* by a clamping-screw; a bevel. The cut shows several forms and positions.

Fig. 670.

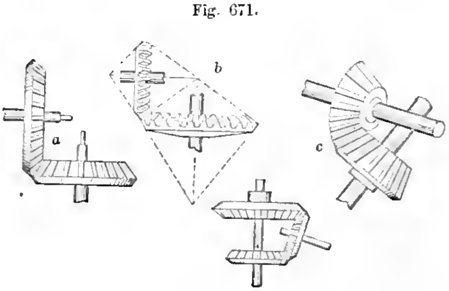


Bevel-Square.

Bev'el-tool. (*Turning.*) A turner's tool for forming grooves and tapers in wood. *Right-hand* or *left-hand* bevels are used, according as the work tapers to the right or left of the workman.

Bev'el-wheel. (*Gear.*) The term is applied to

Fig. 671.



Bevel-Gearing.

a cog-wheel whose working-face is oblique with the axis. Its use is usually in connection with another bevel-wheel on a shaft at right angles to that of the former, but not always so. When the wheels are of the same size and their shafts have a rectangular relation, the working-faces of the wheels are at an angle of 45° with the respective shafts, and the result is *miter* gears *a*. If this relation of the shafts be maintained, but the wheels are varied in size, *b*, the angles of their faces will vary. As before, however, their cogs are cut at right angles to the surface of two cones whose apexes coincide with the point where the axes of the wheels would meet.

When the shafts are arranged obliquely to each other, *c*, a certain obliquity of the cogs of the wheels becomes necessary.

The lower figure in the cut shows a mode of obtaining two different speeds on the same shaft from one driving-wheel.

The term *bevel-wheel* applies in strictness only to a wheel the angle of whose working-face is more or less than 45°, the latter being a *miter-wheel*.

Be-zan. (*Fabric.*) A Bengalee white or striped cotton cloth.

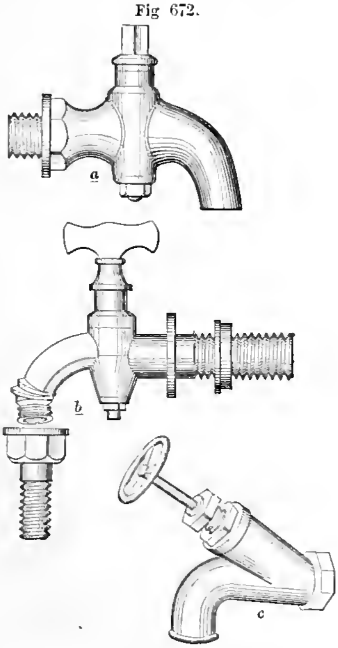
Bez'el. A term applied by watchmakers and jewelers to the groove and projecting flange or lip by which the crystal of a watch or the stone of a jewel is retained in its setting. An *ouch*.

Bib'ble-press. A press for rolling rocket-cases.

Bibbs. (*Nautical.*) Cleats bolted to the hounds of a mast to support the *trestle-trees*.

Bib-cock. A cock or faucet having a *bent down* nozzle ; a *bib*.

Fig 672.



Bib-Cock.

a is a *bib-cock* with a square for the key.

b is a *bib-cock* with a union-joint on the nose for the connection of hose.

c is a *bib-valve*, the closure being by a reciprocating slide instead of a rotary spigot.

Bi'chord Pi-a'no-for'te. (*Music.*) A piano with a grand movement, but possessing but two strings to a note. A *semi-grand* piano-forte.

Bick-i'ron. A small anvil with a tang which stands in a hole of a work-bench. A *beak-iron*.

Bi-cy'cle. (*Vehicle.*) A two-wheeled velocipede. The wheels are in line ; the fore-wheel is driven by the feet.

Johnson's old English patent for a *hobby* was a bicycle. See VELOCIPEDE.

Bid'der-y-ware. (*Alloy.*) This is made at Bider, a town about sixty miles from Hyderabad, India. Dr. Heyne states its proportions as —

Copper	8
Lead	4
Tin	1

To 3 ounces of this alloy 16 ounces of zinc are added when the alloy is melted for use. It is colored by dipping into a solution of sal-ammoniac, saltpeter, common salt, and sulphate of copper. This colors it, and the color forms a ground for the silver and gold inlaying. Chisels and gravers are employed, and after the inlaying is complete, the ware is polished and stained.

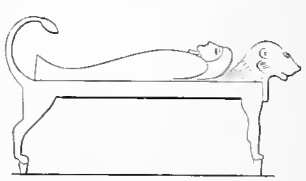
Another formula gives, zinc 128, copper 16, lead 4, tin 2. See ALLOY.

Bi-det'. A form of sitting-bath used for washing the body, the administration of injections, and treatment of hemorrhoids.

Bid-hook. (*Nautical.*) A small boat-hook.

Bier. 1. A hand-barrow adapted to carry a corpse or coffin, or both. Its purpose is its only distinguishing peculiarity to constitute a difference between it and a *stretcher*, *litter*, or *hand-barrow*.

Fig. 673.



Bier.

The bier represented in the accompanying cut was the ordinary form for supporting the dead in ancient Egypt.

The illustration is from the temple at Karnak.

2. (*Weaving.*) A count of 40 threads in the warp or chain of woolen cloth. The number of warp-threads is counted by *biers ;* the threads are termed *ends*. Thus, —

In ordinary broadcloth there are 3,600 threads in the warp ; these are set in a *sley* or *reed*, about $3\frac{3}{16}$ yards wide. Such a warp is said to be 90 biers. In England, 5 biers or 200 threads go to the *hundred*. This is one of the absurd overdrafts ; as, a hundred-weight of 112 pounds ; a dozen consisting of 13. In some trades a hundred consists of 120 pieces or pounds.

40 warp-threads of woolen yarn on the beam : 5 biers make 100 ; that is, 100 pairs of threads, 100 above and the same number below, in the *shed*. Common broadcloth, $1\frac{3}{4}$ yards wide, has 18 double-hundreds, or 3,600 warp-threads. Fine broadcloth may have 6,000 warp-threads.

Bight. (*Nautical.*) The loop of a bent rope.

Bi-la'lo. (*Vessel.*) A two-masted vessel of Manilla.

Bil'an-der. (*Vessel.*) A small two-masted vessel used in Holland, principally on the canals.

Bil'bo. (*Weapon.*) 1. A flexible-bladed cutlass from Bilboa.

"To be compassed, like a good bilbo, in the circumference of a peck, hilt to point, heel to head." — *Falstaff* (in the buck-basket).

2. A form of fetters for prisoners, named from Bilboa, Spain, where they were manufactured in

large quantities, and shipped on the vessels of the Spanish Armada.

A long bar of iron was bolted and locked to the deck; a shackle slipped loosely on the bar, and was secured to the ankle of the prisoner.

"Methought I lay
Worse than the mutines in the bilboes."
Hamlet.

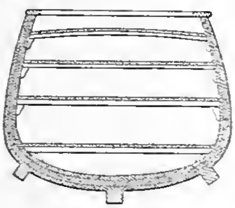
Bilge. 1. (*Shipbuilding.*) The flat portion of a ship's bottom. Here water collects, and is called *bilge-water.* The water is derived from leakage and condensation. The *bilge-water alarm* announces any unusual depth; the *bilge-pumps* remove it.

2. (*Coopering.*) The protuberant middle portion of a cask.

Bilge-board. (*Shipbuilding.*) The board covering the limbers where the bilge-water collects.

Bilge-keel. (*Shipbuilding.*) A longitudinal beam or plate on the bilge of a vessel, for protection from rubbing; or, in the case of iron vessels without true keels, to prevent rolling. Used with vessels having flat bottoms and light draft. The "Warrior" and some other British iron-clads have bilge-keels.

Fig. 674.



Bilge-Keels.

Bilge-piece. (*Shipwrighting.*) An angle-iron or wooden stringer placed at intervals along the bilge of an iron ship to stay and stiffen the frame.

Bilge-plank. (*Shipwrighting.*) Strengthening planks of the inner or outer skin, at the bilge.

Bilge-pump. (*Nautical.*) *a.* One for pumping the water from the bilge of a vessel. In its old form it had a rod carrying a disk (called a *burr*), to which is nailed a hollow inverted cone of strong leather, the upper edge of which is equal to the diameter of the chamber. When it is thrust down it collapses, allowing the water to pass; when it is raised, the leather cap spreads by the weight of the column, and makes a tight joint with the sides of the chamber.

Formerly also known as a *burr*-pump.

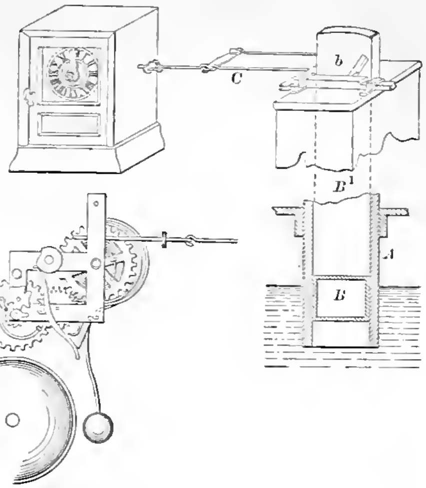
Bilge-pumps are fitted to marine engines as a security to the ship in case of extraordinary leakage, as well as to save the work of the crew in pumping the hold dry. The bilge-pipes should be made of lead, which suffer less corrosion than copper from the acidulous bilge-water of wooden ships.

b. A pump to withdraw water when the ship is laying over so that the water cannot reach the limbers which are reached by the main pumps.

Bilge-wa-ter A-larm'. (*Nautical.*) The ordinary form of these alarms is a well in the hold and a float whose rise is made to free an escapement and sound an ordinary clock-alarm mechanism. In many cases the stem of the float is either graduated to show the hight of the water, or has a rack which operates a spur-wheel and turns an indicator-finger on a dial. These may be read as occasion requires, but are not properly alarms unless with them is associated a device to call attention to the condition of the apparatus.

One form of bilge-water alarm has a vertical rectangular box *A* permanently placed in the water whose rise is to be announced. The float *B* rises with the water, and its stem *B'* has an oblique slot *b*, in which a pin moves and gives motion to a bar *C* connected to clock-work. The latter is placed in any

Fig. 675.

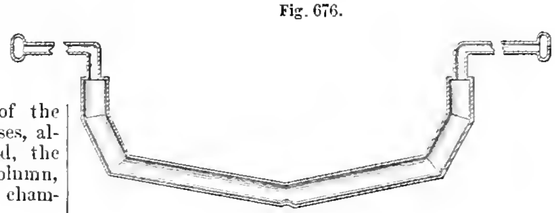


Hydraulic Indicator.

convenient position, and connected to the bar by wire or rods, so as to trip the escapement of the clock-alarm when the float reaches a certain hight. The figures represent, respectively, the indicator-dial, the slotted stem and moving bar, the clock-work, and a vertical section through the float and the lower part of the trunk.

In another form a tube is bent to conform to the

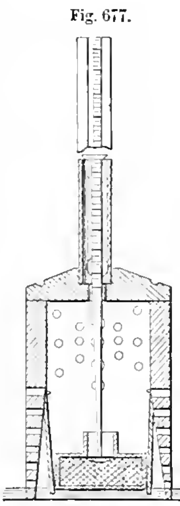
Fig. 676.



Leak-Alarm.

transverse sectional shape of the vessel, and is provided with a whistle at each end. At the lowest midship portion the bilge-water is admitted at a gauze-covered opening. When a considerable amount of bilge-water has collected in the pipe, the rolling of the vessel causes the water to expel the air at alternate ends of the pipe, and sounds an alarm.

Fig. 677.



Bilge-Water Gage.

Bilge-wa'ter Dis-charge'. (*Nautical.*) A device to secure automatic discharge to the bilge-water. A tube extending from the limber through the outer skin has a rear opening through which a current is induced as the vessel passes through the water.

Bilge-wa'ter Gage. (*Nautical.*) A device for showing the depth of bilge-water in the hold. A graduated stem extending upward from a float in the well where the bilge-water collects. As the float rises, the graduations are read by the officer of the watch.

Bilge'way. (*Shipbuilding.*) The foundation of the *cradle* supporting a ship upon the *sliding-ways* during building and launching. The *sliding-ways* consist of planks 3 or 4 inches wide supported on blocks, and the bilgeways of the cradle slip thereon. The bilgeways are about five sixths the length of the ship, and are about 2 feet 6 inches square. The *cradle* is the carriage which bears the ship into the water and separates from the ship by the act of floating.

Bill. 1. (*Agriculture.*) A hook-shaped cutting-implement, used in heavy pruning, hedging, etc. A *bill-hook.*

2. (*Weapon.*) A hook-shaped blade on a staff, formerly used; the halberd of the infantry soldier.

"Have a care that your bills be not stolen."
Dogberry.

The bill or bill-hook, under the name of *falx* or *falcula*, was a common weapon among the Romans. A similar implement was used by the Greeks. The figures of Perseus and Saturn are represented thus armed. With this weapon Jupiter wounded Typhon and Hercules slew the Lernæan Hydra.

3. (*Nautical.*) The point on the end of the arm of an anchor beyond the fluke or palm; the *pee.* It is the first part to penetrate the ground, and is made slightly hooking. See ANCHOR.

4. (*Shipwrighting.*) The end of a compass or knee timber.

5. (*Agriculture.*) A mattock.

6. The point of a hook.

Bill-board. (*Shipbuilding.*) An iron-covered board or double planking which projects from the side of the ship and serves to support the inner fluke of the anchor.

Bil'let. (*Saddlery.*) *a.* A strap which enters a buckle.

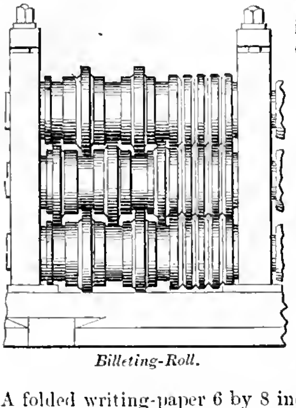
b. A pocket or loop which receives the end of a buckled strap.

Bil'let-head. (*Nautical.*) A piece of wood at the bow of a whale-boat around which the harpoon-line runs; a loggerhead.

Bil'leted Ca'ble. (*Architecture.*) Cabled molding with cinctures.

Bil'let-ing-roll. (*Rolling-Mill.*) A set of rollers for reducing iron to shape, to merchantable bar. In the illustration the passes are shown with flattening and edging grooves.

Fig. 678.



Billeting-Roll.

Bil'let-mold'-ing. (*Architecture.*) An ornament used in string courses and the archivolts of windows and doors. It consists of cylindrical blocks with intervals, the blocks lying lengthwise of the cornice. Sometimes in two rows, breaking joint.

Bil'let-note. A folded writing-paper 6 by 8 inches.

Bill-hold'er. A device by means of which bills, memorandums, or other slips of paper, are held and secured, so as to be readily referred to and withdrawn as required.

There are numerous forms: one consists of an upper and a lower band, whose distance apart may be regulated by means of two elastic straps fastened by hasps or fasteners, which allow the straps to be taken up or let out as required.

Another form is a spring clasp; a third is a wire for impaling, either suspended or standing on a foot.

Bill-hook. A thick, heavy knife with a hooked end, useful for chopping off small branches of trees or cutting apart entangled vines, roots, etc.

When a short handle only is attached, this implement is sometimes called a *hand-bill.*

Its lighter forms correspond in their application to the Spanish *machete.*

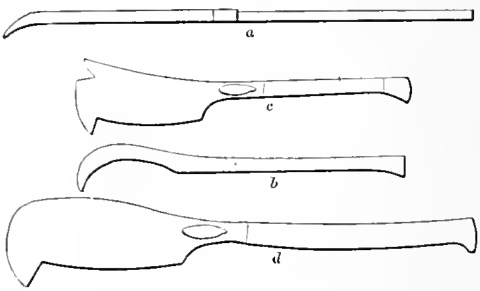
The *bill* is made of a weight and shape proportioned to the work.

The long-handled bill *a* is called a *scimiter;* the handle four feet long.

The short-handled, light-tool *b* is called a *dress-hook*, and is used for trimming off twigs, pruning or cutting back the smaller limbs to preserve the shape of a hedge, shrub, or ornamental tree.

The other two figures, *c d*, represent varieties of bill-hooks for heavier work. The illustrations are from English tools; the bill-hook is but little known among us. The axe, hedge-shears, pruning-knife, and occasionally the corn-knife pressed into service as a *machete*, do the work in the United States. One of the principal uses of these tools in England is for hedging. This is on the advance with us; but, as usual, we have contrived a machine, founded on the principle of the *harvester*, which is drawn by horses and trims the hedge to any required shape. See HEDGE PLANTERS AND CLIPPERS.

Fig. 679.



Bills.

Bil'liard-cue. The rod with which the billiard-ball is struck. It is sometimes tipped with a vulcanized rubber block.

Bil'liard-mark'er. A counting apparatus for registering the points and games at billiards. There are many varieties.

Bil'liards. A game of skill, played on a smooth, level table of peculiar construction, with hard, elastic balls propelled by a tapering stick called the cue. It was invented either in France or Italy, probably during the sixteenth century. The invention is generally ascribed to Henrique Devigne, an artist in the reign of Charles IX., 1571. The game is spoken of by Shakespeare.

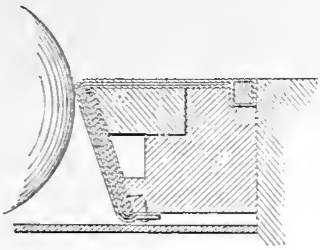
In 1578, during the reign of William, Prince of Orange, permission was given to some residents of Amsterdam to keep billiard-tables.

"Up all of us and to billiards." — PEPYS, 1665.

"After dinner to billiards, where I won an angel." — *Ibid.*

Billiard-tables of the best quality have marble tops covered with cloth. The general appearance is well known. The full-size table is 6 feet by 12, having six pockets, one at each corner and two opposite each other at the midlength of the table. The cushions are the ledges running around the table, which prevent the balls from being projected over its edges; they are lined with resilient material, to cause the balls to rebound, and various materials and devices have been contrived for this purpose, many of which have been the subjects of patents. The cue was introduced about 1670.

Fig. 680.



Billiard-Table Cushion.

Carom tables, destitute of pockets, have come into great favor. The different modes of constructing the cushions have formed the subjects of many patents.

A Kansas billiard-table is thus described: "First, in the middle of the floor was an enormously large box, on which was laid about a wagon-load of sandstone, covered with about eight yards of blue jean. The pockets were made of old boot-legs; for cues they had old hoe-handles; mock-oranges served for balls; and to count this lovely game they used dried apples strung on a clothes-line."

Bil'lon. (*Alloy.*) A German coin-alloy of copper and silver, the former predominating.

Bil'ly. 1. (*Wool-Manufacture.*) A slubbing-machine in which the partially compacted slivers of wool, in the condition of *cardings* or *rolls*, are joined end to end and receive a slight twist, — the preliminary operation in wool-spinning. See SLUBBING-MACHINE.

2. A policeman's mace or club.

Bil'ly-gate. (*Wool-Manufacture.*) The moving carriage in a *slubbing-machine.*

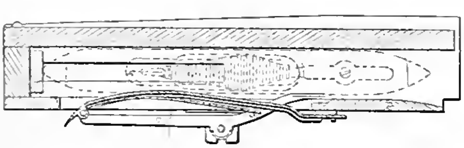
Bi'na-ry-en'gine. Usually an engine having one cylinder whose piston is impelled by steam, which, having done its work there, is exhausted into another part of the apparatus, where it is allowed to communicate its unutilized heat to some liquid volatile at a lower temperature; the vapor of this second liquid, by its expansion in a second cylinder, yields additional useful force. Ether, chloroform, and bisulphide of carbon, have all been tried.

Bind'er. 1. (*Carpentry.*) A *tie-beam.* A binding-joist supporting transversely the bridging-joists above and the ceiling-joists below, to shorten the bearings. See JOIST; FLOOR.

2. (*Shipbuilding.*) A principal part of a ship's frame, such as keel, transom, beam, knee, etc.

3. (*Sewing-machine.*) A device for folding a binding about the edge of a fabric and sewing it thereto. See "Sewing-machine Attachments," a complete digest to 1872, by George W. Gregory, Washington, D. C.

Fig 681.



Shuttle-Binder.

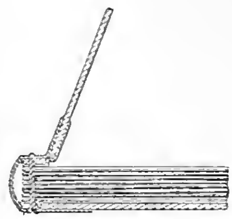
4. (*Agriculture.*) *a.* An attachment to a reaping-machine which binds the gavels into sheaves.

b. A wisp of straw, a cord, wire, or other band for binding a sheaf of grain.

5. (*Weaving.*) A lever applied in a shuttle-box to arrest the shuttle and prevent its rebounding.

6. (*Bookbinding.*) A cover for music, magazines, or papers, forming a temporary binder to keep them in order for convenient reference.

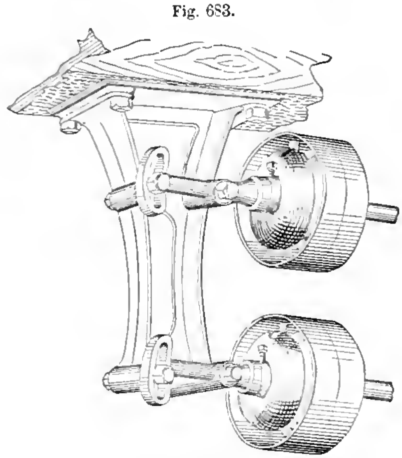
Fig. 682.



Music-Binder.

Bind'er-frame. A hanger with adjustable bearings by which the angular position of the shafting may be regulated to suit the plane of motion of the belting.

Fig. 683.



Binder-Frame.

Bind'er's Board. (*Bookbinding.*) A thick sheet of hard, smooth, calendered pasteboard, between which printed sheets are pressed to give them a smooth surface. Also the stiff pasteboards which form the basis of the sides of book covers.

Bind'ing. (*Bookbinding.*) The putting of a cover on a book. In the trade, *binding* is putting on the sides; following the operations of *folding, gathering, sewing, rounding,* and *edge-cutting,* and preceding the *covering, tooling, lettering,* and *edge-gilding.*

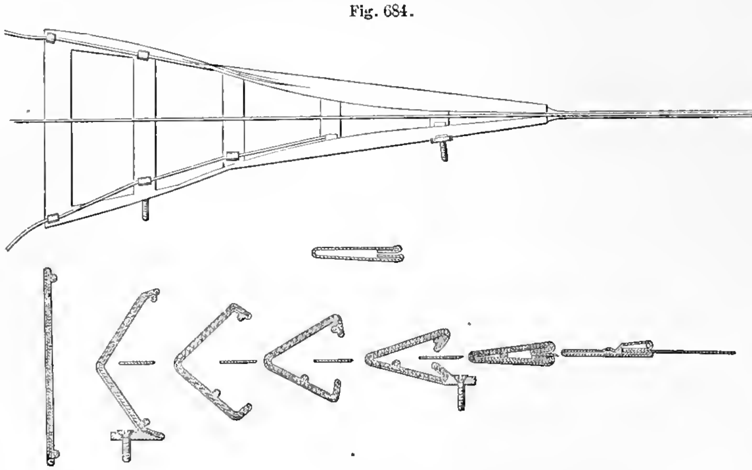
Various kinds of binding are known as —

Antique,	India-rubber,
Beveled,	Levant,
Boards,	Morocco,
Buff,	Muslin,
Calf,	Roan,
Cloth,	Russia,
Crushed,	Sheep,
Full,	Vellum,
Half.	Velvet, etc.

Bind'ing-cloth. (*Fabric.*) Dyed and stamped muslin for covering books. The dyed cloth is passed between engraved rollers, or is worked after being cut into patterns of the required size. The engraved cylinders of hard steel confer the impress characteristic of the back and sides along with embossed designs over the surface in sharp relief. It is a cheap and good substitute for leather, which it has nearly superseded for general use.

Bind'ing-guide. (*Sewing-Machine.*) The device is adapted to receive a binding and fold it about the edge of a piece of material to be bound. Are of two general classes: 1. A flattened tube folded gradually on itself longitudinally from near its receiving to its delivering end, but with a space left for the edge of the material. (See patent to SWEET, December 20, 1853.)

Fig. 684.



Binding-Guide

2. Adjustable hooks projecting through the face of a guide and facing each other; the binding is directed by the guide and hooks, the material to be bound rests between the hooks, and the latter are adjustable, to lap the binding more or less on either side. (See patent to PRICE, June 19, 1860.)

Some binders turn in or hem the edges of a bias strip of cloth as it is applied for a binding. (See patent to DOUGLAS, October 5, 1858.)

Bind'ing-joist. (*Carpentry.*) A joist whose ends rest upon the wall-plates, and which support the *bridging* or *floor joists* above and the ceiling joists below. A *binder*. See JOIST; FLOOR.

The binding-joist is employed to carry common joists when the area of the floor or ceiling is so large that it is thrown into bays. With large floors the *binding-joists* are supported by *girders*. See GIRDER.

Binding-joists should have the following dimensions: —

Length of Bearing. Feet.	Depth. Inches.	Width. Inches.
6	6	4
8	7	4½
10	8	5
12	9	5½
14	10	6
16	11	6½
18	12	7
20	13	7½

Bind'ing-plate. One of the side-plates of a puddling or boiling furnace, which are tied together by bolts across the furnace, and by flanges, and serve to bind the parts of the furnace together and prevent the spreading of the arched roofs of the furnace and iron chamber. See PUDDLING-FURNACE.

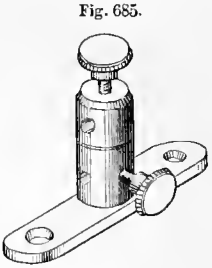
Bind'ing-raft'er. (*Carpentry.*) A longitudinal timber in a roof, supporting the rafters at a point between the comb and eave. See PURLIN.

Bind'ings. 1. (*Shipbuilding.*) The timbers of a ship which hold the *frames* together. Such are the *beams, knees, clamps, water-ways*, etc.

2. (*Nautical.*) The iron wrought around the *dead-eyes*.

Bind'ing-screw. A set-screw which binds or clamps two parts together. The term is applied especially, in instruments of graduation and measurement, to a screw which clamps a part in a given position of adjustment. A screw by which the wire of a galvanic battery is held in close contact with other metallic portions in the circuit.

Fig. 685.



Binding-Screw.

Bind'ing-screw Clamp. (*Galvanism.*) A device used with voltaic batteries; the lower portion is a clamp for the zinc or copper element, which is suspended in the bath; the upper has a hole for the conductor-wire, and a screw which comes forcibly down upon it to ensure contact.

Bind'ing-strakes. (*Shipbuilding.*) Thick strakes, planking, or wales, at points where they may be bolted to knees, shelf-pieces, etc.

Bind'ing-wire. The wrapping-wire for attaching pieces which are to be soldered together, or to hold in intimate contact the parts concerned in a voltaic circuit.

Bind-rail. (*Hydraulic Engineering.*) A piece to which the heads of piles are secured by mortising or otherwise, serving to tie several of them together and as a foundation for the flooring-joists or stringers. A *cap*.

Bing. (*Mining.*) A place for receiving ore ready for smelting. The *bing-hole* is the opening through which it is thrown.

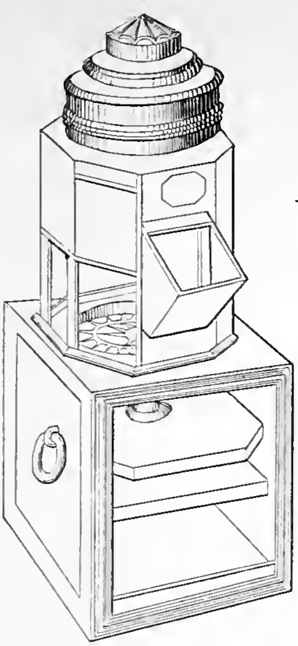
Bink. (*Cotton-Manufacture.*) A stack of cotton in a *bin* or on the floor, consisting of successive layers of cotton from different bales laid in alternating strata, in order to blend them. A *bunker*.

The supply of cotton for the machinery is taken by raking down the take so as to mix the cotton of the successive layers at each *take*.

Bin'na-cle. (Fr. *habittacle*). (*Nautical.*) A case or box for containing the compass of a ship and a light by which it is illuminated at night.

It is placed immediately in front of the wheel or steering-apparatus, and secured to the deck, usually, by metal stays. The after portion has glass windows, so that the compass is at all times visible to the helmsman, who stands at the wheel.

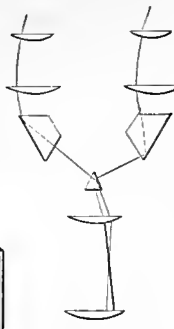
Fig. 686.



Binnacle.

Bin'o-cle. (*Optics.*) A BINOCULAR TELESCOPE (which see).

Fig. 687.



Eye-Piece for Optical Instruments.

Bi-noc'u-lar Eye-piece. (*Optics.*) One in which the eye-piece is so constructed and applied to the object-glass as to divide the optical pencil transmitted to the latter, and form, as to each part of the divided pencil, a real or virtual image of the object beyond the place of division.

Bi-noc'u-lar Glass. (*Optics.*) An eye-glass or telescope to which both eyes may be applied.

Alhazen, the Saracen, who flourished in Egypt and in Spain A. D. 1100, "was the first to correct the Greek misconception as to the nature of vision, showing that the rays of light come from the external object to the eye, and do not issue from the eye and impinge on external things, as up to his time had been supposed. His explanation does not depend upon mere hypothesis or supposition, but is plainly based upon anatomical investigation as well as on geometrical discussion. He determines that the retina is the seat of vision, and that impressions made by light upon it are conveyed along the optic-nerve to the brain. With felicity he explains that we see single when we use both eyes, because of the formation of the visual images on symmetrical portions of the two retinas." — DRAPER.

The camera-obscura of Leonardo da Vinci, b. 1452, was an imitation of the mechanical structure of the eye.

Samuel Pepys, in "His Diary," records a conversation with Dr. Scarborough on board the "Charles," formerly the "Nazeby," on the voyage of Charles II. from the Hague to Dover, May 24, 1660. Dr. Scarborough remarked that custom taught children to direct the axes of the two eyes convergingly upon an object, and presumed that the visual image of but one eye was appreciated at a time. Dr. Scarborough does not seem to have deduced from this that the images differed, and thus imparted the sensation of rotundity or saliency to the object, nor the other fact that the angle of convergence of the axes gave the impression of distance. He came very near to these great deductions.

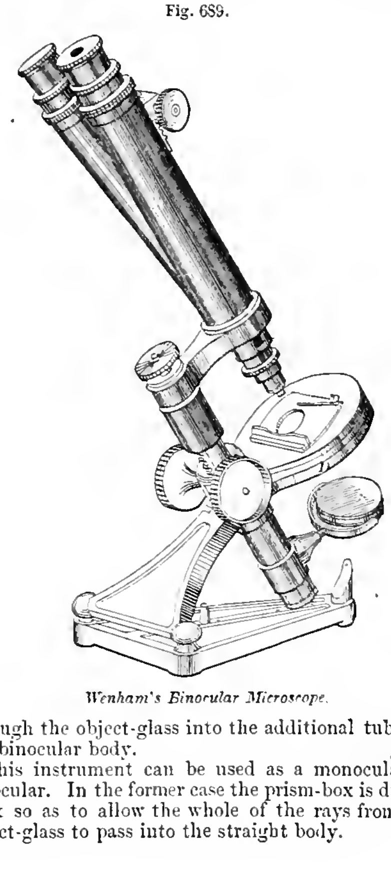
A good illustration of the principle of binocular vision is furnished by the stereoscope, invented by Professor Wheatstone, and forming one result of his discoveries. When we are looking at a raised object with one eye, the result is just the same as if we looked at a flat surface, so far as the colors, shades, etc., are skillfully imitated; but when we look with both eyes, the image in the right eye is not exactly like that in the left, because we view it from a different point of sight. It is true, that this difference depends only on the small distance between the eyes, but this suffices to produce different ocular images. Wheatstone has shown that our appreciation of raised objects depends mainly on this circumstance; and his *stereoscope*, or *binocular glass*, is an ingenious contrivance for making two plain pictures seem to coalesce into one rilievo, or raised object.

Bi-noc'u-lar Mi'cro-scope. (*Optics.*) The invention of the binocular microscope followed that of the stereoscope by Professor Wheatstone, which led to a general appreciation of the value of binocular vision.

Professor Riddel, of New Orleans, and after him Wenham, of London, made attempts to adapt the principle to microscopes. Professor Nachet, of Paris, devised a construction in which the pencil of rays issuing from the objective is divided by an equilateral triangular prism, and, issuing from the right and left sides respectively, the divided pencils are received by similar prisms, which give them a direction parallel to their original course; the interval of separation being determined by the distance between the central and lateral prisms.

Wenham's binocular microscope has but a single prism, which reflects one half of the rays passing through the object-glass into the additional tube of the binocular body.

Fig. 689.



Wenham's Binocular Microscope.

This instrument can be used as a monocular or binocular. In the former case the prism-box is drawn back so as to allow the whole of the rays from the object-glass to pass into the straight body.

Bi-noc'u-lar Tel'e-scope. (*Optics.*) A pair of telescopes mounted in a stand, and having a parallel adjustment for the width between the eyes. The tubes have a coincident horizontal and vertical adjustment for altitude and azimuth.

Galileo invented the binocular telescope with which he experimented in the harbor of Leghorn on a vessel in rough weather in the year 1617, with a view to the more convenient observation of Jupiter's satellites on board ship. The invention has usually been attributed to the Capuchin monk Schyrleus de Rheita, who had much experience in optical matters, and was seeking to find the means of constructing telescopes which would magnify four thousand times.

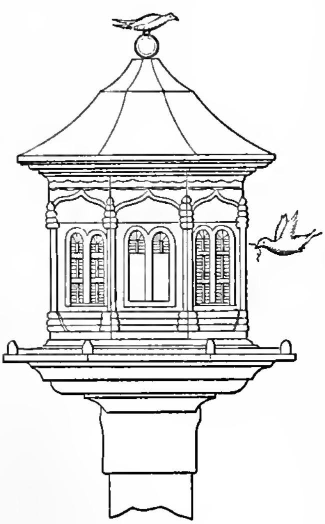
Bi'not. (*Agriculture.*) A kind of double-mold board-plow. (English.)

Bird-bolt. A thick, pointless arrow to kill birds without piercing them.

Bird-cage. A box or case of wire, small sticks, wicker, or other suitable material, forming open-work, for confining birds. Pepys states that he bought two fine cages for his "canary-birds. (*Diary*, January 25, 1661.) See CAGE.

Bird-call. A short metallic cylinder, with a circular perforated plate at each end; used to make a trilling noise, as a decoy for birds.

Fig. 689.



Bird-House.

Bird-house. A box for birds, usually set on a pole planted in the ground to prevent access of cats and other vermin. May be made an architectural feature, but is usually a modest affair, put up for the pleasure of seeing the birds and the satisfaction of affording them comfort and protection.

Bird'ing-piece. A fire-arm for killing birds. A shot-gun or FOWLING-PIECE (which see).

Bird-or'gan. A small barrel-organ, used in teaching birds, especially the bullfinch, to sing.

Bird's-mouth. (*Carpentry.*) The notch at the foot of a rafter where it rests upon and against the plate.

Bird's-nest. (*Nautical.*) A lookout-station at a mast-head for a seaman who watches for whales.

Bird-trap. A two-winged flap-net sprung by hand, or a box-trap supported on a figure-of-4, with a trigger to be touched by the bird or sprung by a person on watch. The netting of birds by the former method is well pictured in the ancient Egyptian paintings.

Bi'reme. (*Nautical.*) A two-banked galley.

Bir'lin. (*Nautical.*) Bior-linn; a galley of the Hebrides.

Bir'rus. (*Fabric.*) An old-time coarse woolen cloth.

Bis-cay'an Forge. A furnace in which malleable iron is obtained direct from the ore. See CATALAN.

Bis'cuit. 1. (*Bread.*) *a.* A hard cake of unfermented bread, suitable for sea use. Formerly it was baked a second time to expel the moisture more completely, in order that it might keep without molding. A *cracker.*

b. A small baked cake, rendered spongy by carbonic-acid gas resulting from fermentation, or adding soda and an acid. Or, a small baked cake with shortening of lard or butter.

2. Articles of pottery molded and baked in an oven, preparatory to the glazing and burning. In the *biscuit* form, pottery is bibulous, but the glaze sinks into the pores and fuses in the kiln, forming a vitreous coating to the ware.

Biscuit, by its derivation, means, *twice baked*, and is, or was, true of the edible biscuit; but the name as applied to pottery is derived from the similarity which the ware in this stage bears to the edible biscuit. It is a favorite material for statuettes and ornaments, owing to its soft tone and creamy unglaring surface.

Bis'cuit-mak'ing Ma-chine'. Previous to the introduction of machines for kneading the materials, rolling the dough, and cutting out the biscuits, the flour and water were mixed and kneaded by hand, and then placed on a platform where, by means of a hinged lever called a *break-staff*, the process is completed, the person sitting on the break and bouncing up and down, and at the same time traveling in the arc of a circle, leaving the dough in a thin sheet, very compact and comparatively dry. This was removed from the platform, cut into slices, molded by hand, pricked, and baked.

The biscuit-machine of the Navy Victualling Establishment, Portsmouth, England, is thus described in the United Service Journal: —

"The first operation in making the biscuits consists in mixing the meal and water. 13 gallons of water are poured into a trough, and then 280 pounds of meal. The lid is shut down, and an apparatus, consisting of two sets of knives, is made to revolve among the flour and water by machinery. The mixing lasts 2½ minutes, during which the stirrers make 26 revolutions.

"The lumps of dough are then thrown under the *breaking-rollers*, which are cylinders of iron weighing about 1,500 pounds each, and moved by machinery upon the bench whereon the dough is laid. The dough is thus formed into masses about 6 feet long, 3 feet broad, and several inches thick. The mass, being as yet imperfectly kneaded, is cut into sections about 12 × 18 inches of the thickness mentioned, and is again and again mashed out flat by the traversing roller, being doubled upon itself after each rolling.

"The dough, now perfectly kneaded, is carried by machinery to the rollers, where it is made into sheets of the required thickness. The cutting is effected by a plate, consisting of a network of 52 sharp-edged hexagonal frames, each as large as a biscuit. The frame is moved slowly up and down by machinery, and the workman, watching his opportunity, slides under it the sheet of dough, which is about the size of a leaf of a dining-table. The cutting-frame, in its descent, indents the sheet, not cutting it quite through, but leaving sufficient substance to enable the workman at the mouth of the oven to jerk the whole mass of biscuits undivided into the oven. A follower in each of the cutter-frames moves up and down, giving way as the cutters are pressed upon the dough, and, as the cutters rise, ejecting the dough from the frames.

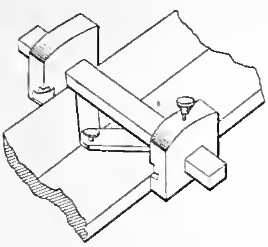
"The establishment has 9 ovens, each 11 × 13 feet, and 17½ inches in hight. They are heated by separate furnaces, so constructed that a blast of hot air and fire sweeps through them, and gives to the interior the requisite dose of heat in an incredibly short space of time. Fifteen minutes is sufficient for baking, and the biscuit are afterwards placed for three days in a drying-room heated to 80° or 90°, which completes the process.

"The producing capacity of the machinery is 1,790 pounds of biscuit per hour."

Bi-sect'ing Di-vid'ers. Proportional dividers whose legs are permanently pivoted at one third of their length from the shorter end, so that the distance between the two points at that end, when the dividers are opened, is just one half that measured by the longer legs.

Bi-sect'ing Gage. The bar has two cheeks, one adjustable. The ends of the toggle-bar connect to the respective cheeks, and at the pivot of the toggle is a pencil or scribe-awl which marks a median line between the facing sides of the two cheeks.

Fig 690.



Bisecting Gage.

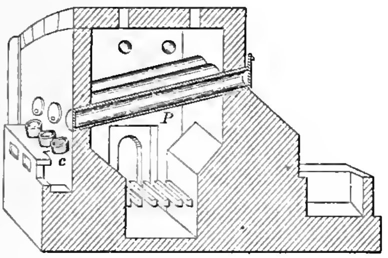
Bis'muth. Equivalent, 212; symbol, *Bi;* specific gravity, 9.823; fusing-point, 497° F. A reddish-white, hard, brittle metal, of radiated crystalline structure.

Its principal use is as an ingredient in alloys, especially those which are designed to fuse at low temperatures, such as the solders and fusible plugs for steam-boilers.

The oxide of bismuth is a cosmetic. See ALLOYS, under the heads of *white metals; solders; fusible alloys.*

Bis'muth Fur'nace. At Sceneberg, in the Saxon Erzegebirge, bismuth is reduced in a furnace similar to that shown in the cut. The raw mineral is in-

Fig. 691.



Bismuth Furnace.

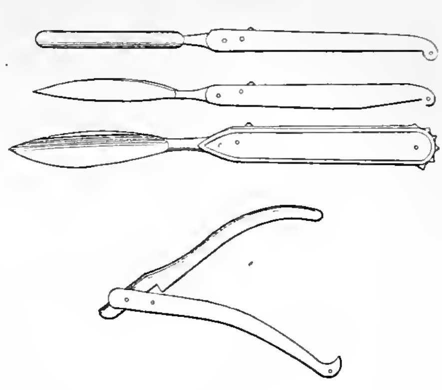
serted into the higher ends of the iron tubes *P*, which are then shut. The lower ends of the tubes are closed by plates having an aperture near the lower edge, through which the melted metal flows, and is received in clay-pots *c*, which are kept hot by a fire beneath. In this state it contains a proportion of sulphur and arsenic, which, however, may be removed by fusing the metal with one tenth its weight of niter.

Bisque. (*Porcelain.*) The baked ceramic articles which are subsequently glazed and burned to form porcelain. See BISCUIT.

Bis'tou-ry. (*Surgical.*) From Pistori, a French town where these knives were early made.

A surgical instrument for making incisions, having a handle and a blade, which may be either fixed or

Fig. 692.



Bistouries.

movable, and variously formed to adapt it to special purposes. Bistouries are known as straight, curved, sharp, probe, etc.

Bi-sul'phide of Car'bon En'gine. A compound engine in which the vapor from bisulphide of carbon is employed in the second cylinder instead of steam as a motive-power. A binary engine.

Two engines are used in the Ellis arrangement. They may be coupled together or used independently. One of these engines is run by steam in the usual way, and its exhaust taken to heat the boiler that drives the other engine; this boiler is filled with a mixed volatile liquid, consisting principally of the bisulphide of carbon, which boils at 110° F., and at the usual temperature of exhaust steam gives a pressure of 65 pounds to the inch. This boiler is heated by passing the exhaust steam through its flues on its way from the cylinder to the atmosphere, and the vapor which is produced in it is used to drive the second engine. The exhaust vapor from this engine is condensed to liquid by cooling, and pumped into the boiler again, and used continuously with very little loss.

Bit. 1. (*Locksmithing.*) The part of a key which enters the lock and acts upon the bolt and tumblers. See KEY.

The *bit* of a key consists of the *web* and the *wards.* The *web* is the portion left after the wards are notched, sawn, or filed out.

In the permutatious locks, each separate piece composing the acting part of the key is termed a bit. These fit upon the stem of the key, from which they are removable, and are interchangeable among themselves, so as to allow the key to be set up with various combinations agreeing with the set of the tumblers.

2. (*Wood-working.*) *a.* A boring tool used by attachment to a *brace*, whereby it is rotated. An *auger* has many points of resemblance to a *bit*, but has a cross-handle whereby it is rotated, whereas a bit is stocked in the socket of a brace, and is rotated thereby.

The following are the varieties of Boring-Bits, and their adjuncts: —

Annular bit.	Broach.
Auger.	Bung-borer.
Auger-bit.	Center-bit.
Awl.	Chamfering-bit.
Bit-holder.	Coal-boring bit.
Boring-bit.	Cone-bit.
Brad-awl.	Countersink-bit.

Dowel-bit.
Drill.
Drill-bit.
Ducks-bill bit.
Expanding-bit.
Faucet-bit.
Felloe auger.
Flute-bit.
French-bit.
German-bit.
Gimlet-bit.
Gouge-bit.
Grooved bit.
Hollow auger.
Shell-auger.
Lip-bit.
Nose-bit.
Opening-bit.
Piercel.
Pod-bit.
Plug-center bit.
Pump-bit.
Quill-bit.
Reaming-bit.
Shell-bit.
Spiral bit.
Spiral-rib bit.
Spoon-bit.
Terrier.
Twisted bit.
Vent-bit.
Wimble.

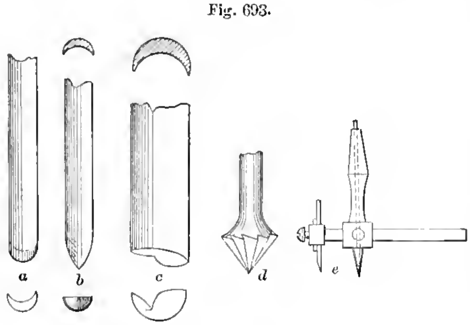
The *gouge-bit* (*a*, Fig. 693), before the invention of the *pod*, *spoon*, and *twisted bits*, resembled the half of a reed split longitudinally, and had a sharp end like a gouge. This was also known as the *quill-bit*, or *shell-bit*.

It was improved by giving a quarter-round end to the semi-cylindrical shank, the sharp end working at the bottom of the hole and removing a spiral chip instead of depending upon the penetration of the sharp end of the tube, as in the gouge-bit. This was a great improvement, and was the *pod-bit*, or *lip-bit*.

The change to the *spoon-bit* (*b*) was merely giving a conoidal end to the tool, which enabled it to enter more accurately at a given spot. This is the *dowel-bit*, being used by coopers on barrel-heads, and by furniture-makers on table-leaves. This is also called the *duck's-bill bit*.

The *nose-bit* or *shell-auger* (*c*), when on a large scale, has the first example of a *table* or *routing* cutter, which is afterwards so prominent a feature in the screw-augers. It has a long barrel, and the large sizes are used by the pump-makers, and called *pump-bits*.

Fig. 693.



Boring-Bits.

One form of *countersink-bit* has a cutting enlargement on the shank, which, according to its shape, may make a suitable depression for the chamfered head of a screw, its usual purpose, or may serve to sink a bolt-head or nut out of sight in the material. See CHAMFER.

In another form, attached to the shaft of a boring-bit is a countersink, or cutting lip, that will enlarge the hole bored by the bit, it being adjustable on the bit, and having a gage to determine the depth of hole or countersink.

The countersink has two faces, either of which may be presented to the work. One has a tooth and router, which makes a square-bottomed countersink; and the other has a chamfering lip, which makes a conical countersink.

The *chamfering-bit* (*d*), for opening holes so as to admit the conical heads of the ordinary wood-screw, consists of a conical reamer with teeth. It may be employed on wood, metal, or other material which is to receive the head of the wood-screw.

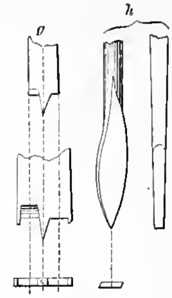
The gage is adjustable on the countersinker, and the latter on the stem of the bit, so the hole may be made of a regulated depth, and the countersink also.

Other gages adaptable to the use of bits are shown under the head of AUGER-GAGE (which see).

The *expanding center-bit* (*e*) consists of a shank and center-point, and a lancet, or chisel-shaped cutter, whose distance from the center is regulated by slipping the bar, like that of a beam-compass, in the socket of the head, a set screw maintaining it at its adjustment. This serves for cutting out disks, or for cutting circles for inlaying.

For cutting hard wood, such as the finger and key holes of flutes, bits are employed with a square point and two diametrical cutting-lips (*g*, Fig. 694); the smaller one approaches very closely the character of a drill, into which, indeed, many of the bits sensibly glide, especially those adapted for working in hard woods, and other materials harder than wood, such as bone and metal.

Fig. 694.



Boring-Bits.

The *French bit* (*h*), for hard wood, is a drill, and as such is used in a lathe-head. The center-point and two sides merge into an easy curve, which is sharpened all the way round and a little beyond the largest part.

The German *pod-bit* (*k*, Fig. 695) has a long elliptical pod and a screw-point. It makes a taper to the end of the hole unless it is driven clear through.

The *center-bit* consists of three parts: a center point or pin, filed triangularly, which serves as a guide for position; a thin cutting-point or nicker that cuts through the fibers and circumscribes the hole; and a broad chisel-edge or router, placed obliquely, and tearing up the wood within the circle marked out by the point.

Center-bits are also made with plug centers, so as to follow in a hole previously made, the *circular cutter* and *router* enlarging the hole. See AUGER.

Another form of the center-bit is that of the wine-cooper, which consists of a conical plug armed with a bit at its end. The hole having been made, the plug instantly drops into the hole and prevents the loss of liquor. See AUGER.

An annular bit, consisting of a center-point without the *router*, but having one or more cutting teeth, is used to cut out disks of metal, wood, horn, bone, shell, or paper for buttons. It is then called a *button-tool*. (See *c*, Fig. 693.) See AUGER, ANNULAR, where several are represented, which only differ in size from the button-tool. This tool also approaches, in principle and action, the TREPHINE and CROWN SAWS (which see).

Twisted drills, differing in some details, are in much favor among American mechanics, but for some reason are not so popular in Europe. They are an American invention, and the subject having been treated once under AUGERS (which see), it will not be well to duplicate the remarks, or perhaps necessary to add to them here.

There are four modes of forming the twist, though they are not equally popular or common: —

A ribbon coiled.

A flat plate twisted.

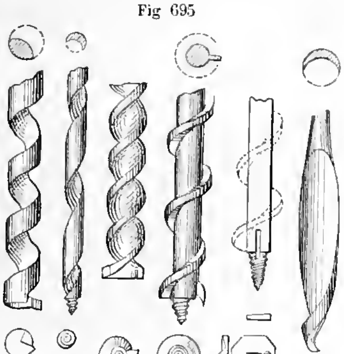
A spiral rib on a straight, central stem.

A spirally grooved cylinder.

The spiral ribbon *m* is a bar having a half-round section. This is twisted so as to throw the flat side to the exterior to form the outside of the cylinder; the inside is not filled up by the metal, but makes a hollow spiral, and the bottom end has a single cutting-lip.

The twisted flat bar *n* assumes the form of a double-threaded screw, no central vacancy existing in the twist. The end terminates in a worm which *leads* the auger into its work, as in the gimlet, and each of the two lips has a cutting tooth and a routing cutter.

Fig 695



m s n o p k

Spiral-Bits.

The *spiral-rib* bit *o* is known, especially in England, as the American bit, and has a cylindrical shaft, around which is twisted and brazed a single fin or rib; or the bit may be swaged between dies, or twisted from a central stem with a single straight rib.

Behind the worm, as in example *p*, may be a small diametric mortise for the reception of a detached cutter which has the nicking-point and cutting-lip of the ordinary center-bit. The cutter is kept in its central position by a square notch which embraces the central shaft of the bit, against which it is forced by a wedge. Cutters of varying sizes may be used.

The *grooved* bit *s* has a cylindrical stem and spiral groove. The groove-shanked gimlet is an example of it.

The Cook and the Kasson bits, in which the cutting-lips are formed by sharpening the curved edges of the worm, are referred to under AUGER (which see). They cut admirably.

The *reaming* bit is a broach of hardened steel, generally four-sided, and used to enlarge holes in metal.

Expanding-bits are useful in two ways: —

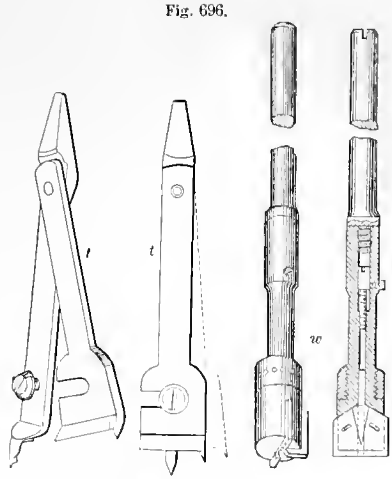
To render a single bit applicable for boring holes of varying sizes.

To enlarge the size of a hole beneath the surface, giving it an undercut or dovetail character.

One form of *expanding-bit*, *t*, has a central portion which has the point, and a hinged portion which carries the scribe and the router. The movable portion is set by a screw, so as to regulate the radius of the hole.

Another form, *w*, has three radial cutters, which are expanded by means of a taper wedge and an axial screw. The latter is operated by a screw-driver,

Fig. 696.



Expanding-Bits.

whose end is introduced into the socket, the threaded end of which is the means of securing it to the brace, chuck, or mandrel.

b. The cutting-iron of a plane. See PLANE-BIT.

c. The cutting-iron inserted in the revolving head of a planing, molding, tonguing, and grooving, or similar machine.

d. The cutting-blade of an axe, hatchet, or similar tool, as distinguished from the pole, which forms a hammer in some tools.

3. (*Harness.*) The iron part of a bridle which is inserted in the mouth of a horse, and having rings by which the *cheek-straps* and reins are attached. See BRIDLE-BIT.

4. (*Jaw-Tools.*) The jaw of a tongs, pinchers, or other similar grasping-tool, e. g. *flat-bit* tongs.

5. (*Tinman's Tools.*) The copper piece of a soldering-tool riveted to an iron shank. A *copper-bit.*

6. (*Metal-Working.*) A boring-tool for metal, many of which are called *bits;* as, *half-round bit, rose-bit, cylinder-bit.* See DRILL.

7. The metallic connecting joint for the ribs and stretchers of umbrellas.

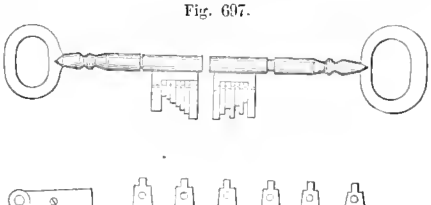
A ∩-shaped piece of metal swaged into shape and clamped or soldered to the rib, which is secured to it by a wire pin passing through an eye in the stretcher and holes in each of its legs. The cross-formed blank is bent up to embrace the back of the rib and closed on to it; the legs are pierced with holes for the joining-pin; *Middle-bit; Get.*

Bite. (*Printing.*) An imperfect portion of an impression, owing to the frisket overlapping a portion of the form and keeping the ink from so much of the paper.

Bite-in. (*Engraving.*) The process of corroding an etched plate. See ETCHING.

Bit-key. A key adapted for the permutation

Fig. 697.

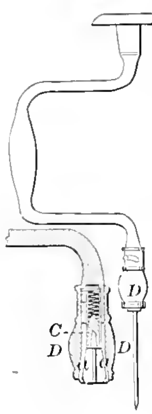


Bit-Key.

lock, the *steps* being formed by movable bits, as in the Hobbs lock.

Bit-stock. The handle by which a bit is held and rotated. It has a flat button upon which the pressure is exerted, and is curved about midway into a D-shape, to afford convenient grasp to the hand. Also called a *brace*. The special devices usually relate to means for firmly holding and readily releasing the bit. In Fig. 698, the end of the shank of the bit abuts against a sliding center-piece *C* backed by a spring. The shoulder of the tool is embraced by the jaws *a a* on the end of the bit-stock; these are closed or opened by a sleeve *D*, which has an inclined slot traversed by a pin, which prescribes the longitudinal motions of the sleeve.

Fig. 698.



Bit-Stock.

Bit-pinch'ers. (*Locksmithing.*) Pinchers having curved or recessed jaws.

Bitt. (*Nautical.*) Primarily, a post secured to several decks, and serving to fasten the cable as the ship rides at anchor. *Riding-bitt; warping-bitt.*

Other *bitts* are used for certain purposes; as —

a. The *pawl-bitts*, to which the pawls of the windlass are secured.

b. The *carrick* or *windlass bitts*, in which the barrel of the windlass is journaled.

c. *Winch-bitts*, similar in purpose to *b*.

The heel of the bowsprit is stepped between *bowsprit-bitts*, and is prevented from canting up by a cross-piece bolted to the bitts.

d. *Belaying-bitts* are smaller than *riding-bitts*, and consist of two upright posts and a cross-piece. They are used for belaying the larger ropes, such as the sheets and braces.

For belaying ropes in order of size, —

A riding-bitt.	A belaying-cleat.
A kevel.	A belaying-pin.
A belaying-bitt.	

Bit'ter-end. (*Nautical.*) The part of the cable abaft the bitts. The last end of a cable in veering out. The clinching end.

Bitt-heads. (*Shipbuilding.*) The upright timbers bolted to several decks, and serving as posts to which the cable is secured. They correspond to *bollards* on a wharf or quay. *Knight-heads.*

Bit'ting-rig'ging. (*Saddlery.*) A bridle, surcingle, back-strap, and crupper. The bridle has a gag-rein and side-reins, the latter buckling to the surcingle. The rigging is placed on young horses to give them a good carriage, but must be released occasionally, as the bent position of the neck and elevation of the head is unnatural, and takes time to acquire.

Bitt-stop'per. (*Nautical.*) A rope rove through a knee of the riding-bitt and used to clinch a cable.

Bi-zet'. (*Diamond-Cutting.*) The upper faceted portion of a brilliant-cut diamond which projects from the setting. It has one third of the whole depth of the gem, being cut in 32 facets, which occupy the zone between the *girdle* and the *table*. See BRILLIANT.

Black. The pigment which absorbs all the light rays is usually carbon in some form.

Charcoal is prepared by heating wood to redness in a position protected from the oxygen of the atmosphere.

Bone-black is prepared by the distillation of bone in retorts.

Animal charcoal is another name for *bone-black*.

Ivory-black is a bone-black obtained from cuttings, raspings, dust, and scraps of ivory.

Lamp-black is the soot obtained by collection from the burning of impure and refuse resinous matters and oils.

Spanish-black is the carbon of cork.

Peach-black is obtained from peach-stones.

Frankfort-black is the carbon obtained from the marc of grapes, wine-lees, peach-kernels, and bone-shavings.

German-black is another name for the Frankfort.

Vine-black is the carbon of the grapevine.

Graphite, also called *plumbago* and *black-lead* (misnomers), is a form of mineral carbon. See BONE-BLACK; CHARCOAL; LAMP-BLACK, etc.

Blackboard. A diagram board used in schools and lecture-rooms for the public demonstration of problems, the exhibition of examples, and the illustration of propositions in natural philosophy, etc. They are prepared by closely joining together well-seasoned boards planed smooth, and painting them with several coats of black paint mixed with finely pulverized pumice-stone or similar material, so as to impart a slight roughness to the face, that the chalk employed in writing may leave distinct marks on the board and yet rub off freely.

Black'en-ing. 1. (*Founding.*) An impalpable powder, usually charcoal, employed by molders to "dust" the "partings" of the mold.

2. (*Leather-Manufacture.*) A solution of sulphate of iron applied to the grain side of the skin while wet; it unites with the gallic acid of the tan, and produces a black dye.

Black Flux. (*Metallurgy.*) A material used to assist in the melting of various metallic substances. It is made by mixing equal parts of niter and tartar, and deflagrating them together. The black substance which remains is a compound of charcoal and the carbonate of potassa.

Black-ground Il-lu'mi-na-tor. (*Optical Instrument.*) One in which an opaque surface is introduced behind the object, while illuminating rays are directed around and upon it. For forms of this see SPOT-LENS; PARABOLIC ILLUMINATOR.

Black'ing. A composition for polishing leather.

Recipes. Liquid blacking: 1. Ivory-black, 5 oz.; treacle, 4 oz.; sweet oil, $\frac{3}{4}$ oz.; triturate until the oil is thoroughly mixed in; then stir in gradually $\frac{1}{4}$ pint each of vinegar and beer lees.

2. Ivory-black, 1 lb.; sperm-oil, 2 oz.; beer and vinegar each one pint, or sour beer 1 quart.

3. BRYANT and JAMES's patent india-rubber liquid blacking: india-rubber (in small pieces), 18 oz.; hot rapeseed-oil, 9 lbs. (1 gall.); ivory-black, in fine powder, 60 lbs.; treacle, 45 lbs.; add gum-arabic, dissolved in vinegar, 1 lb.; triturate the mixture in a paint-mill; place in a wooden vessel, and add 12 lbs. sulphuric acid; stir daily $\frac{1}{2}$ hour for 14 days; then add 3 lbs. of gum-arabic, and repeat the stirring daily for 14 days, when the blacking will be ready for use.

Paste: —

Ivory-black	4 pounds.
Molasses	3 pounds.
Sperm-oil (hot)	9 ounces.
Gum-arabic	1 ounce.
Vinegar	12 ounces.

Mix; stir occasionally during 6 days. More vinegar will liquefy the compound.

The addition of sulphuric acid to ivory-black and sugar produces sulphate of lime, and soluble acid phosphate of lime, which makes a tenacious paste.

Liebig's recipe : —

Ivory-black	8
Molasses	4
Hydrochloric acid	1
Sulphuric acid	2
Water	*ad. lib.*

Harness-blacking : 1. Glue or gelatine, 4 oz. ; gum-arabic, 3 oz. ; water, ¾ pint ; dissolve by heat ; add treacle, 7 oz. ; ivory-black (in very fine powder), 5 oz. ; and gently evaporate until of a proper consistency when cold, stirring all the time. To be kept corked.

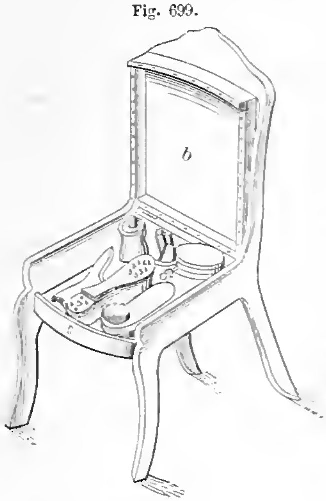
2. Mutton-suet, 2 oz. ; beeswax, 6 oz. ; melt, add sugar candy, 6 oz. ; soft soap, 2 oz. ; lampblack, 2½ oz. ; indigo (in fine powder), ½ oz. ; when thoroughly incorporated, add oil of turpentine, ¼ pint.

3. Beeswax, 1 lb. ; ivory-black, ¼ lb. ; prussian blue, 1 oz. (ground in linseed-oil, 2 oz.) ; oil of turpentine, 3 oz. ; copal varnish, 1 oz. ; mix well together, and form into cakes while warm.

4. To the last, while still hot, add soft soap, 4 oz. ; oil of turpentine, 6 oz. ; put into pots or tins while still warm.

Black'ing-brush. A brush for cleaning, blacking, or polishing boots ; a stiff brush for removing dirt ; a soft brush for applying the blacking, and a medium brush for polishing. A blacking and a polishing brush on the respective sides of the same brush-back is the usual arrangement.

Fig. 699.



Blacking-Case.

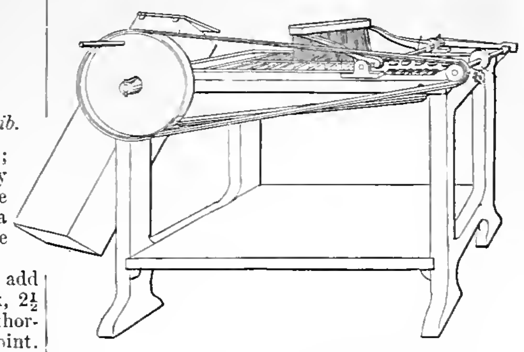
Black'ing-case. A case for blacking and brushes. That shown in Fig. 699 has a receptacle in the chair-seat which contains the appliances and also a foot-rest. The seat *b* is hinged, and serves as a cover to the receptacle.

Black-jack. (*Mining.*) A native sulphuret of zinc. Also known as *mock-lead*. See BLENDE.

Black-lead. A native form of carbon sometimes containing traces of iron. The terms *black-lead* and *plumbago* are misnomers, as the article has no lead in its composition, though it gives a mark like lead when drawn over a surface. *Graphite* is the preferable term, referring to its uses in writing and drawing. See GRAPHITE.

Black-lead'ing Ma-chine'. A machine for coating the surfaces of electrotype molds with plumbago. The carriage which supports the mold is moved gradually along the bed beneath the brush, which has a quick, vibratory movement in the same direction. The graphite, being sprinkled on the mold, is caused to penetrate the recesses of the letters in the matrix by the penetrating points of the bristles.

Fig. 700.



Black-Leading Machine.

Black-plate. The sheet-iron plate before tinning.

Black'smith's Chis'el. Blacksmith's chisels, for cutting iron bars, are divided into two principal classes, for hot and for cold iron, distinguished from each other by the different angles of the cutting edge, and by the former kind having a wooden handle inserted through an eye at right angles to the length of the chisel.

The hardy is a chisel having a tang fitting into a hole in the anvil. (See ANVIL.) When used upon hot iron, the chisel has a withe of hazel or other soft wood wound around it.

Black'smith's Tools. See the following : —

Anvil.
Barnacles.
Bar-shoe.
Battery-forge.
Beak.
Bellows.
Black-work
Bore.
Butteris.
Calking-anvil.
Calking-tongs.
Calking-tools.
Calking-vise.
Calk-sharpener.
Calk-swage.
Cautery.
Chisel.
Clincher.
Collar-tool.
Coupler.
Creaser.
Cutting-shoe.
Die.
Drift.
Foot-rest.
Forge.
Forge, Portable
Forging-machine.
Fuller.
Fullering-tool.
Hammer.
Hand-hook.
Hardy.
Hoof-spreader.
Horse-holder.
Horseshoe.
Horseshoe anvil.
Horseshoe machine.
Horseshoe nail.
Horseshoe nail-machine.
Horseshoe vise.
Jam-weld.
Jumping.
Lunette.
Mandrel.
Miter-iron.
Monkey.
Oliver.
Ox-shoe.
Pliers.
Porter.
Prick-punch.
Pritchel.
Punch.
Riveting-tools.
Rounding-tool.
Searing-iron.
Slake-trough.
Sledge.
Snap-head.
Stifle-shoe.
Stock.
Stock and dies.
Stocks.
Striker.
Swage.
Swage-block.
Tap.
Tilt.
Tilt-hammer.
Tire-bender.
Tire-heater.
Tire-shrinker.
Toe-calk.
Tongs.
Top-tool.

Triblet.
Tuyere.
Twitch.
Upsetting-machine.
Welding-swage.

Black-strake. (*Shipbuilding.*) The strake next below the lower or gun-deck ports.

Black Tin. (*Mining.*) Tin ore, washed and dressed, beaten into a black powder, and ready for smelting.

Black-wall' Hitch. (*Nautical.*) A bend to the back of a tackle-hook or to a rope, made by passing the bight round the object and jamming it by its own standing part. See HITCH.

Black-work. The work of the blacksmith in contradistinction to bright-work or the work of the silversmith.

Blade. In a mechanical sense this is a sharp instrument, relatively long, thin, and flat. It is applied to objects which have the proportions of a knife or sword, such as the sharp-edged beaters in hemp or flax brakes, the cutters in some descriptions of corn-harvesters, and to other objects which have the function of knives or cutters.

A *blade*, in usual parlance, is that of a knife, sword, axe, adz, saw, and is less frequently applied to the tools which are driven endwise, such as the chisel and gouge.

1. (*Nautical.*) *a.* The part of the anchor-arm which receives the palm, forming a ridge behind the latter.

b. The *wash* of an oar; that part which is dipped in rowing.

2. The *web* of a saw.

3. (*Weapon.*) *a.* The *blade* of a bayonet consists of the

Point,
Back,
Flat,
Fullers or *grooves.*

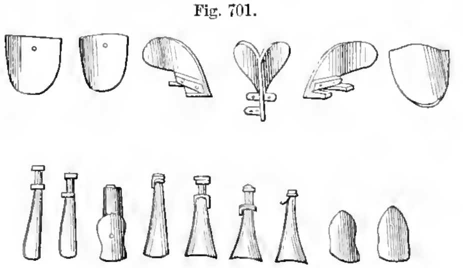
b. The flat metallic portion of a knife or sword which is secured in the *handle* or *hilt* by a *tang.*

The blade of a sword consists of the
Shoulder; at the junction of the tang.
Forte; half the blade nearest the guard.
Foible or *faible;* half the blade nearest to the point.

Tang.
Point.
Back.
Flat.
Edge.

4. (*Agriculture.*) The share of a shovel-plow, cultivator, or horse-hoe. These are of various forms.

Fig. 701.



Plow and Cultivator Blades.

5. (*Shipwrighting.*) The float or vane of a paddle-wheel or propeller.

Blanc'ard. (*Fabric.*) A linen cloth of Normandy, made of half-bleached thread.

Blan'chard Lathe. A lathe for turning irregular forms, invented by Thomas Blanchard. It was the first successful lathe for turning gun-stocks, axe-handles, shoe-lasts, etc. The idea was partly elicited in Brunel's block-turning machine. See BLOCK-MAKING MACHINE; LATHE.

Blanched Cop'per. (*Metallurgy.*) An alloy composed of copper, 8 oz., and ½ oz. of neutral arsenical salt, fused together under a flux of calcined borax, charcoal-dust, and fine powdered glass.

Tin or zinc is added in the white *tombac* of the East Indies, — *mock silver.*

Blanch-im'e-ter. An instrument for measuring the bleaching power of a chloride. See CHLORIMETER.

Blanch'ing. (*Metallurgy.*) Tinning of copper.

Blank. 1. (*Architecture.*) *Blank doors* or *blank windows* are imitations, and used for ornamentation or to secure uniformity in the design.

2. (*Metal-working.*) *a.* A piece of metal brought to the required shape and ready for the finishing operation, whatever it may be.

b. A *planchet* of metal, weighed, tested, and milled, is a *blank* ready for the die-press, which converts it into a *coin.*

c. A strip of softened steel made into the required shape is a *blank*, which cutting and tempering transform into a *file.*

d. A piece of iron with a flaring head, and otherwise properly shaped ready for nicking and threading, is a screw-blank, which with the final operations becomes a screw.

The list might be prolonged, but the above is sufficiently indicative.

Blank-car'tridge. An inclosed charge of powder without shot. Used for firing warnings or salutes and in exercising troops.

Blank-cut'ting Ma-chine'. (*Metal-working.*) A machine for cutting out pieces of metal for fabrication into articles; such as keys, files, buttons, etc.

Blank'et. 1. (*Fabric.*) A coarse, heavy, open, woolen fabric, adapted for bed covering, and usually napped. It may be twilled or otherwise. A name applied to any coarse woolen robe used as a wrapping.

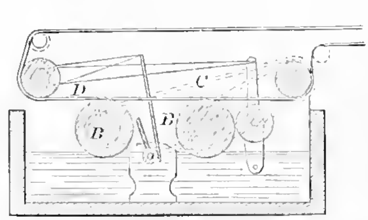
> "Antiphanes, that witty man, says:
> 'Cooks come from Elis, pots from Argos,
> Corinth blankets sends in barges.'"
>
> ATHENÆUS (A. D. 220).

The *poncho* is a blanket with a hole in the center for the head to go through. It is worn by the South Americans, Mexicans, and Pueblo Indians.

2. (*Printing.*) A piece of woolen, felt, or prepared rubber, placed between the inner and outer tympans, to form an elastic interposit between the face of the type and the descending platen.

Blank'et-wash'er. A machine for washing printer's blankets. Ordinarily it consists of a vat

Fig. 702.



Blanket-Washer.

and rollers, the blanket being alternately soaked and squeezed. In the illustration a scraper or *doctor* is used to clean the roller. A similar machine is used for calicoes and other fabrics.

Blank-tire. A tire without a flange.

Blare. (*Nautical.*) A paste of hair and tar for calking the seams of boats.

Blast. 1. (*Metal-working.*) An artificial current of air to urge a fire; as, *hot-blast*: *cold-blast*.

2. (*Engineering.*) The exploding of a bursting charge, for rending rocks, etc. See BLASTING.

3. (*Steam-Engineering.*) Exhaust steam directed up a chimney to urge a fire.

Blast-en'gine. (*Pneumatics.*) *a.* A ventilating machine on shipboard to draw foul air from below and induce a current of fresh air.

A machine for urging the fire of a furnace. See BLOWER.

Blast-fur'nace. (*Metallurgy.*) A furnace into which a current of air is artificially introduced, to assist the natural draft or to supply an increased amount of oxygen to a mineral under treatment.

Fig 703.

Blast-Furnace.

Fig. 703 is a perspective view of the furnace. The hot-blast apparatus is seen at the left. In front is the sand-bed, into which the metal flows to form pigs.

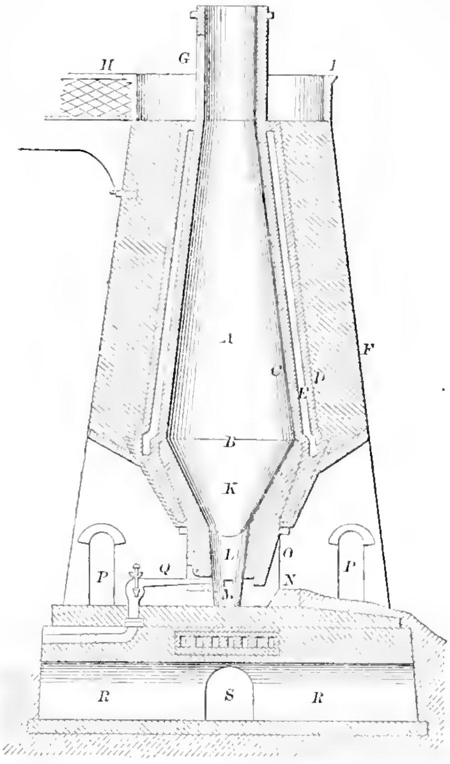
The parts of a blast-furnace are named as follows: —

A, shaft, fire-room, tunnel; the internal cavity.

B, belly; the widest part of the shaft.

C, lining, shirt; the inner coat of fire-bricks.

Fig. 704.



Blast-Furnace Section.

D, second lining, casing; an outer casing of brick with an interval between it and the former.

E, stuffing; the filling of sand or coke-dust between the *lining* and *casing*.

F, mantle, outer-stack, building; the outer wall of masonry.

G, mouth, furnace-top; the opening at top for the ore, coal, and limestone.

H, landing, platform; the stage or bank at the furnace *mouth*.

I, wall, crown, dome; the wall around the furnace-top.

K, boshes; the lower part of the furnace descending from the *belly*.

L, hearth; the pit under the boshes, by which the melted metal descends.

M, crucible; the hearth in which the cast-iron collects. The lowest part is the *sole*.

N, dam; a stone at the end of the fire-hearth.

Tap-hole; an opening cut away in the hardened loam of the dam.

O, tymp-arch, working-arch, folds, faulds; the arch of the *mantle* which admit to the *fire-hearth*.

P, tuyere-arch, twyer-arch; arch of the mantle which leads to the *tuyeres*.

Q, *tuyere, twyer, twere*: the cast-iron pipe which forms the nozzle for the blast.

R, *S*, arches for ventilation.

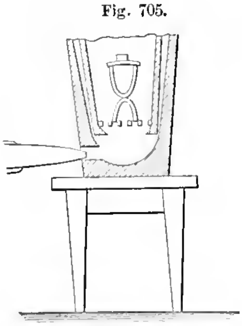
T, channels in the masonry for the escape of moisture.

A large Welch blast-furnace contains 150 tons of ignited material (iron-ore, coke, and limestone-flux), and requires 20,000 cubic feet of air per minute. The weight of the air thrown into the furnace every 24 hours is nine times the weight of the charge of fuel, ore, and flux.

Blast-furnaces are now built as much as 103½ feet high, 27½ feet at the bosh, and 8 feet at the hearth. The average make of such a furnace is 550 tons weekly. The consumption of coke is 16 cwt. per ton of iron made, and 9¼ cwt. of limestone per ton of iron when forge-iron is produced. The blast is supplied by six tuyeres to each. A cast-iron pipe is carried around each surface, from which smaller pipes branch off at equal distances to the tuyeres. These pipes are covered by a non-conducting composition, but wrought-iron pipes may be used in place of these, lined with fire-brick inside four inches in thickness. The furnaces are plated outside, and closed at the top on the cup and cone principle. The blowing-engine for the two furnaces has a 67-inch steam-cylinder, 130-inch blowing-cylinder, 10½ foot stroke. The stoves used heat the blast to 1,400°. Four stoves are required for each furnace. Each stove has two rows of pipes; there are nine double pipes in each row, 11 feet in length; the pipe is of the flat form, the two passages in each being 13 inches by 4 inches inside, divided by a partition 1 inch thick, the whole of the metal being of that thickness, which renders them much lighter than the old form of pipes.

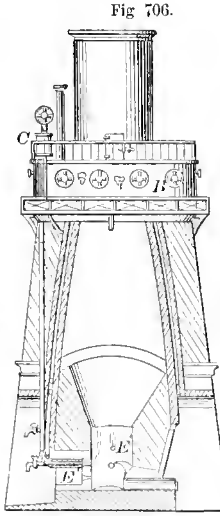
The blast enters at one side of a row of pipes, and must pass through nine double pipes before it makes its exit at the other side. The figures apply to the Cleveland ore, England. See SMELTING.

Fig. 705.



Laboratory Blast-Furnace.

Fig 706.

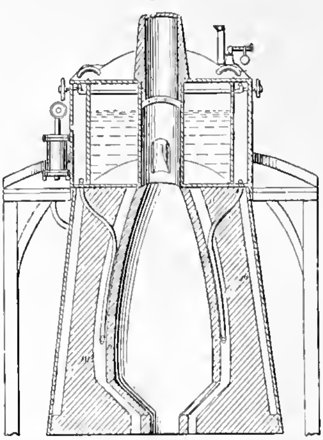


Blast-Furnace.

A small blast-furnace for the laboratory, such as that used by Faraday at the Royal Institution, consists of an outer pot, which is bored for the nose of the bellows, and an inner pot, whose bottom was cut off and the interior fitted with a grating. Pounded glass-pot powder was packed while wet in the interval between the two pots. The fuel is coke. The outer pot is 18 inches high and 13 inches external diameter. The inner pot has 7½ internal diameter at top and 5 inches at bottom.

Fig. 706 shows a view, partly in section, of an arrangement in which an annular boiler surmounts the ore-chamber of the furnace, and its steam passes by a pipe to a tube, where it is associated with a hot-blast from an air-pump, and the combined fluids are driven through the tuyeres into the furnace. The air-pump *C* keeps up a uniform blast, and is itself driven by the steam from the boiler *B*. Hot air and superheated steam are mingled and injected into the furnace at the tuyeres *E' E*.

Fig. 707.



Blast-Furnace.

Fig. 707 shows a somewhat different form of furnace, with the boiler in section. The jacket-boiler surmounts the ore-chamber, forming the tunnel-head of the furnace. An inclined chute passes through the boiler, and is the means of supplying the ore and coal. The pipes conducting the steam are laid in cement.

Blast-hearth. (*Metallurgy.*) The Scotch ore-hearth for reducing lead ores.

Blast-hole. (*Hydraulics.*) The induction water-hole at the bottom of a pump-stock.

Blast'ing. The process of rending rocks, etc., by means of boring, filling the hole with an explosive, and then firing it off. Improvements appertain to the modes of drilling the holes, the composition of the explosive, and the means of igniting.

Gunpowder is said to have been first used for blasting in Germany or Hungary, A. D. 1620; and some German miners, brought to England by Prince Rupert, introduced the practice at the copper mine of Eckford, in Staffordshire, the same year.

The preliminary operation in blasting consists in boring or drilling holes, in which are to be placed the charges of gunpowder or other explosive materials employed to rend the rock.

The implements ordinarily used for this purpose are the jumper, or drill, the hammer, and the scraper. The jumper is a bar of iron, in length proportioned to the depth of hole to be bored, and is faced with steel for a part of its length: those of 1½ inches diameter and upward are worked by three men, two of whom strike alternately on the end of the jumper with hammers, while the third turns it so as to constantly present the cutting edge to a fresh surface of stone.

This is a slow and laborious operation, experience having shown that in granite three men working as above with a jumper of 3 inches diameter, such as is used for boring holes from 9 to 15 feet deep, would not penetrate more than about 4 feet per day on an average; or with a 2½-inch jumper, 5 feet per day, the last being employed for holes from 5 to 10 feet deep.

Churn-jumpers are so called from the manner in which they are worked, by a vertical churning or pounding movement, no hammer being employed; they have a steel bit at each end, are usually worked by two men, and are generally of smaller diameter than those which are worked by a hammer; in drilling holes that are vertical or nearly so, and in moderately hard rock, they are found more advantageous than the others, two men being able to bore about 16 feet per day with a churn-jumper of $1\frac{1}{8}$ to $1\frac{1}{2}$ in diameter. They are sometimes used with a spring rod and line, much in the manner of the most primitive way of boring artesian wells.

General Burgoyne mentions seeing the same device in use in blasting the calcareous rocks of Marseilles, at the foot of the hill on which the fort of Notre Dame de la Garde now stands.

The common way of charging the hole is, where the moisture is not excessive, to pour loose powder into it to a certain depth, depending on the judgment of the miner (one third the depth of the hole is a common allowance under ordinary circumstances); the needle, which is a wire sufficiently long to reach well down into the charge of powder, and provided with a handle to enable its easy withdrawal, is then inserted and the hole tamped, a wad of hay, straw, dry turf, or other suitable material, being first placed over the powder; the tamping is performed by ramming down small fragments of broken brick or of stone which does not contain silex to endanger striking fire, by means of an iron bar called a tamping-rod; when the hole is tamped nearly up to the level of the ground, an inch or two of moist clay is usually placed over the tamping, and the needle withdrawn; it may be remarked that the needle should be frequently turned as the ramming proceeds, so that it may be withdrawn without disturbing the tamping. The priming is effected by pouring fine grained powder down the hole left by the needle, or, what is better, straws filled with powder are pushed down, communicating with the blasting charge; a bit of slow-match or touch-paper, calculated to burn long enough to allow the workmen to retire to a place of safety, is then ignited, and placed in contact with the priming.

In the construction of the Southeastern Railway 400,000 cubic yards of compact chalk were lifted from the face of the Round Down Cliff, two miles west of Dover, England, at a single blast.

Three charges were employed, placed in chambers, 70 feet apart, the center and largest one being placed at a salient point 72 feet, and those on each side each 56 feet distant from the face of the cliff. The charges of powder were 7,500 lbs. in the main chamber, and 5,500 lbs. in each of the others. Shafts tapering from bottom to top were driven downward from a driftway previously cut in the rock, and from the bottoms of these shafts galleries were cut at right angles to the driftway. These were also enlarged at their inner extremities, to secure the tamping. The chambers were cut at right angles to the galleries. After charging, a dry wall of chalk was built across the mouths of the chambers; the galleries and shafts were tamped with the same material, and the tamping was extended into the driftway 10 feet on each side of each shaft. Three Daniell's batteries and three sets of wires were used for firing the mines, which was done simultaneously. The mass of rock removed averaged 380 feet in hight, 360 in length, and 80 in thickness. See ARTESIAN-WELL; TUNNEL; WELL-BORING; and Specific Indexes under CIVIL ENGINEERING and MINING.

See Raymond's "Mines, Mills, and Furnaces": J. B. Ford & Co., N. Y., 1871. Blake's "Mining Machinery": New Haven, 1871. Also, "Blasting and Quarrying of Stone and Blowing up of Bridges," by Lieutenant-General Sir J. Burgoyne of the English Military Engineers. No. 35 of Weale's Rudimentary Series: London.

The following table from General Sir Charles Pasley's "Memoranda on Mining" will give the means of calculating the space occupied by any given quantity of powder in round holes of different sizes, from one to six inches: —

Diameter of the hole.	Powder contained in one inch of hole.		Powder contained in one foot of hole.		Depth of hole to contain 1 lb. of powder.
Inches.	lb.	oz.	lb.	oz.	Inches.
1	0	0.419	0	5 028	38 197
$1\frac{1}{2}$	0	0.942	0	11 304	16.976
2	0	1 676	1	4.112	9.549
$2\frac{1}{2}$	0	2.618	1	15 416	6.112
3	0	3.770	2	13.240	4 244
$3\frac{1}{2}$	0	5.131	3	13.572	3.118
4	0	6.702	5	0.424	2 387
$4\frac{1}{2}$	0	8.482	6	5.784	1 886
5	0	10.472	7	13.664	1.528
$5\frac{1}{2}$	0	12.671	9	8.052	1.263
6	0	15.080	11	4.960	1.061

The following table shows the quantity of powder required to lift from its bed rock of usual weight (about $1\frac{3}{4}$ tons to the perch) and ordinary consistence.

Line of least resistance.	Charges of powder.		Line of least resistance.	Charges of powder.	
Feet.	lb.	oz.	Feet.	lb.	oz.
1.0		$\frac{1}{2}$	4	2	0
1.6		$1\frac{3}{4}$	4.6	2	$13\frac{1}{2}$
2 0		4	5	3	$14\frac{1}{2}$
2 6		$7\frac{3}{4}$	6	6	12
3.0		$13\frac{1}{2}$	7	10	$11\frac{1}{2}$
3.6	1	$5\frac{1}{2}$	8	16	0

The obstruction known as Blossom Rock in the harbor of San Francisco was removed by constructing a coffer-dam around a portion of the rock, a porous sandstone, and excavating its interior, leaving a shell about 6 feet thick, supported by props, to resist the pressure of the water. The space excavated measured 140 by 50 feet, and varied in depth from 4 to 29 feet. 23 tons of powder were used, part of which was inclosed in water-proof casks, and the remainder in iron tanks. These were connected by insulated wires with an electric battery. When all was ready, the coffer-dam was removed, and the water permitted to fill up the excavation, acting as a tamping. The result is represented to have been entirely successful.

Maillefert's process in removing *Way's Reef* in the Hurl-Gate (Hell Gate) obstruction, on the East River, N. Y., consisted in depositing a quantity of powder on the surface of the rock to be removed, and then exploding it. There is no cumbrous apparatus used. A sounding-pole to ascertain the depth, a boat to contain the operators, and an electric battery, are the machinery employed. The explosion is effected by electricity, and it is the same thing whether the operators are stationed near or far, they need never be in danger.

The force of the current is such as to render it difficult to fix drilling apparatus. The process was successful on prominences and to a certain extent; where a broad area was flat, the value of the process rapidly diminished.

Shelburne's apparatus on the *Frying-pan Rock*, in the same estuary, was a heavy stamping-drill, operated by a steam-engine, and acting in a tube which directed its blows; the hole obtained receiving a charge of nitro-glycerine.

The work of removing the obstructions in the East River has now devolved upon the United States Engineers, under General Newton. They are proceeding by building coffer-dams and driving headings. It is a regular tunneling business, and when the whole roof is blown off and the pillars broken off, the new river-bottom will be the bottom of the drifts, plus what of the rock may fall back into the hole. Such can be grappled and removed.

Nitro-glycerine, dualin, dynamite, and various other compounds of terrific energy, are used in these great engineering projects. It is understood that nitro-glycerine has been the principal agent in the Mount Cenis tunnel, as it has been for some years past in the Hoosac.

The idea of blasting by a torpedo in the bottom of an oil-well, to open crevices and increase the flow of oil, seems to have been entertained by a number of persons, including Professor Hare, but was reduced to practice by Colonel Roberts. See TORPEDO.

Blast'ing-fuse. The common blasting-fuse is merely a tube filled with a composition which will burn a sufficient length of time to allow the person firing it to reach a place of safety before it is burnt out.

Safety-fuse, by which the charge can be fired by a man at a considerable distance, is also generally employed. Some of these consist of a tape of soft material saturated with a highly inflammable compound (fulminates are, we believe, employed in some to increase the speed of the flame), and covered with an envelope of water-proof material. Firing by electro-battery is much safer.

Blast'ing-nee'dle. A long taper piece of copper, or iron with a copper point; used when tamping the hole for blasting, to make by its insertion an aperture for a fuse or train.

Blast'ing-pow'der. It was formerly thought that a slow-burning powder, containing a comparatively small proportion of niter, — about 62 per cent, — was more effective for blasting purposes, allowing more time to produce a rending effect upon rock before being consumed than the quicker and stronger powder used in fire-arms; but the tendency now is toward the use of substances of far greater rapidity of ignition, and greater expansion in the act of assuming the gaseous state, than even the strongest gunpowder.

Among more than thirty patented compositions for blasting powder are the following ingredients. The specific combination in each case might be given would space permit.

1. Forms of carbon: —

Burnt cork.	Gambier.
Charcoal.	Brown coal.
Lycopodium.	Peat.
White sugar.	Logwood.
Sawdust.	Bark.
Horse-dung.	Carbolic acid.
Starch of flour.	Aloes.
Petroleum products.	Paraffine.
Cutch.	Fatty matters.
Tannin.	Resins.

2. Metallic salts, etc.: —

Chl. potash.	Carbonate of soda.
Red sulph. arsenic.	Nitrate of lead.
Ferro-cyan. potassium.	Ammoniacal salts.
Nitrate of potassa.	Nitrate of soda.
Sulphur.	Carbazotate of potash.
Chloride of sodium.	Azotate of potash.
Cyanuret of zinc.	Nitrate of iron.
Barilla.	Nitric acid.

Blast'ing-tools. Baron Lièbhaber of Paris obtained a patent in France, 1845, for a mode of enlarging the lower part of a blast-hole by the application of muriatic or other acid 1 part, diluted in water 3 parts.

A tube (*k*, Fig. 708) is inserted in the hole and externally sealed around the lower end with a composition which prevents the rising of the vapors of the acid in the space between the tube and the sides of the hole. The acid is poured into a funnel and down an inner tube, the annular space forming a duct for the escape of the gas, the spent liquid escaping at a bent spout. The hole is then emptied by a siphon or pump, and dried to prepare it for the charge.

The principal blasting tools are —

The *hammer*, for striking the borer.

Borer, or *jumper*. *Drill*.

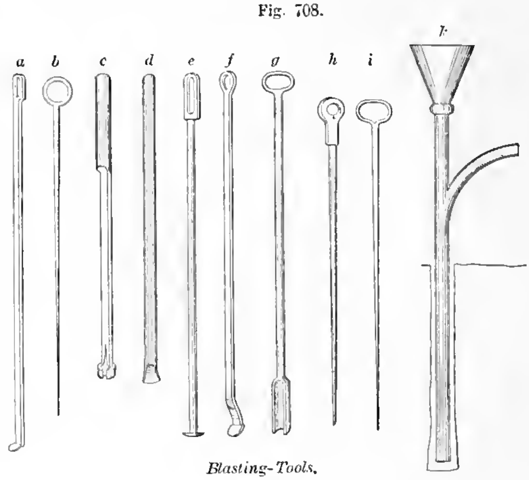
Gad; a wedge for driving into openings made by a pick.

Pick.

Scraper; for clearing the hole.

Needle, or *priming-wire*; a thin copper rod whose withdrawal leaves a vent whereby the charge is reached.

Fig. 708.



Blasting-Tools.

Claying-bar, *tamping-iron*, or *rammer*: for driving down the tamping.

The *fuse*, or *match*.

a e f, scrapers for clearing the blasting-hole.

b h i, needles for pricking the cartridge.

c, tamping-bar.

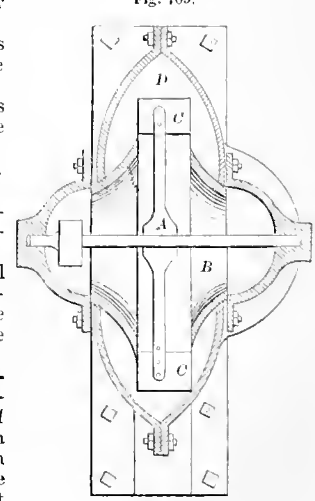
d, drill.

g, bar for ramming in the cartridge.

k, funnel and pipe for introducing acid to enlarge the bottom of the hole.

Blast-ma-chine'. (*Pneumatics.*) A fan *A* inclosed within a box *B*, to which the wings *C* are attached, so that the whole revolves

Fig. 709.



Blast-Machine.

together. It is closely fitted within a stationary exterior case *D*, into which it is journaled. Air is admitted at the sides around the axis, and forced out through an aperture at the periphery by the rapid rotation of the fan, which may, by belt and pulley connections, be driven at the rate of 1,800 revolutions per minute. See BLOWER.

Blast-me'ter. (*Pneumatics.*) An anemometer applied to the nozzle of a blowing engine.

Blast-noz'zle. The orifice in the delivery-end of a blast-pipe. A *tuyere.*

Blast-pipe. (*Steam-Engine.*) A pipe conveying the escape-steam from the cylinders up the smoke-stack of the locomotive to aid the draft. Its invention is ascribed to George Stephenson.

Blaz'ing Com'et. A form of pyrotechnics.

Blaz'ing-off. (*Metal-working.*) Tempering by means of burning oil or tallow spread on the spring or blade, which is heated over a fire.

Bleach'ing. The art of removing color from fabrics, etc. It was known in India, Egypt, and Syria, and in ancient Gaul.

As at present practiced, the process dates back only to the beginning of the present century.

Linen was formerly sent from England to Holland to be bleached. This was performed by several months' exposure to air, light, and moisture. The linens were spread on the ground and sprinkled with pure water several times daily. They were called Hollands, and the name still survives.

In 1749 the system of *bucking* and *crofting*, that is, soaking in alkaline lye and spreading on the grass, was introduced into Scotland. After five or six repetitions of these processes, the linen was dipped in sour milk and then *crofted*. The processes were repeated. The cotton manufacture at this time was in its earliest infancy.

The next improvement was the substitution of dilute sulphuric acid for sour milk. This reduced the time one half.

Scheele, in 1774, had discovered chlorine ; and Berthollet, in 1784, ascertained that an aqueous solution of chlorine discharged vegetable colors. This he communicated to Watt, and it was soon adopted in Scotland with linen. Berthollet added potash to the water to preserve the health of the workmen and the texture of the goods.

Dr. Henry, of Manchester, substituted lime for potash, the goods being passed through a cream of lime and then exposed to chlorine. This formed a chloride of lime on the cloth.

In 1798, Tennant, of Glasgow, adopted a saturated solution of chloride of lime, and subsequently impregnated dry lime with the gas, making bleaching powder.

Bleaching, of cotton goods especially, is conducted on a systematic large scale, and includes singeing and washing ; the former to remove the fibrous down from the surface, and the latter to remove the dirt and impurities acquired in spinning and weaving.

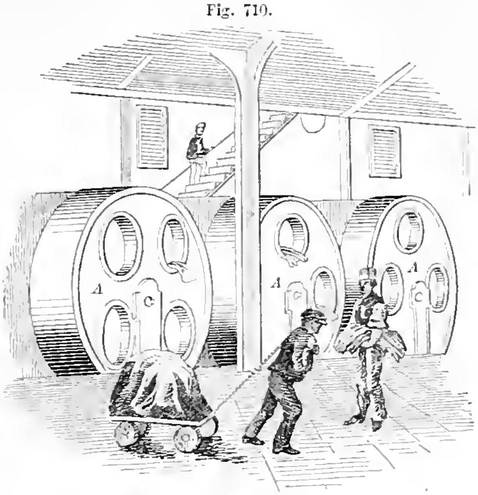
The following process is employed for cotton goods : —

In singeing, the cloth is passed rapidly over a red-hot roller, which removes protruding fibers.

The cloth is then placed in the dash-wheels *A A A* (Fig. 710), which rotate on horizontal axes, and have quadrantal compartments which hold the cloth. Water is introduced through the hollow axes, and a rapid rotation subjects the cloth to the combined effects of agitation and the dashing of the water.

The cloth is next *bucked*, or washed by an alkaline solution which removes the greasy and resinous matters. The goods are placed on the grated bottom of a vat, in the center of which is a stand-pipe by which the stream of boiling alkaline solution is brought in a shower upon the cloths. A deflecting plate on

Fig. 710.



Dash-Wheels.

the top of the stand-pipe distributes the water upon the cloths, through which it percolates and finds its way down through the grating, to be again pumped up. See BUCKING-KIER.

This shower of boiling alkaline solution is maintained for about seven hours, after which the cloth is again washed in the wheels.

The cloths are now *chemicked* by steeping for six hours in a dilute solution of chloride of lime, after which they are steeped in what is called a *souring* vat ; this is a bath of very dilute sulphuric acid, which disengages the chlorine from the lime, and brings the gas into intimate contact with the fiber, which is thereby *bleached.*

The washing, boiling, bleaching, and souring are repeated as may be necessary to produce the complete effect.

The process takes from 24 to 48 hours, and the cloths are handled by machinery.

Linen is now bleached in a similar way, but the operation is more troublesome and requires a longer time, on account of the greater affinity of the material for coloring matter.

Wool is bleached by exposing it to the action of fuller's-earth and soap in a fulling-mill, after which it is washed and dried. When it is intended to preserve it white, it is usually run through water tinged with indigo, or exposed to the fumes of burning sulphur. The last method, unless very carefully conducted, is apt to cause the goods to acquire a harsh feeling, which is removed by washing in soap and water, but this usually reproduces the original yellowish-white tinge.

Silk is bleached by boiling in white soap and water, and then carefully rinsing it. When required to be very white, the material is usually subjected to the fumes of burning sulphur. Straw is generally bleached by the fumes of sulphur, but oxalic acid or chloride of lime is preferable.

Bleach'ing Pow'der. Chloride of lime.

Bleb'by-glass. Glass with blisters and air-bubbles.

Bleed'ing. (*Bookbinding.*) Cutting into the printed matter of a book when cutting the edges.

Blende. (*Mining.*) Otherwise known as *black-*

jack. A native sulphuret of zinc, which is treated by roasting, and destructive distillation in combination with charcoal in a vessel from which the air is excluded.

By access of air the metal burns and passes off as the white oxide, which is collected and forms a pigment known as zinc-white.

Bleu-tur'quin. A kind of marble taken from the quarries of Genoa and elsewhere. It is of a deep blue upon a white ground, mixed with gray spots and large veins.

Blind. For apparatus to assist the *blind* in writing, printing, or reading, see EMBOSSING-TYPE FOR THE BLIND; PRINTING FOR THE BLIND; WRITING-FRAME.

Grenville's invention (English) for teaching the blind was in 1785.

1. (*Carpentry.*) A sun-screen or shade for a window.

Outside blinds are known as *Spanish, Florentine, Venetian*, or *shutter*.

Inside blinds are known as *Venetian, dwarf, spring, common roller, wire-gauze, perforated zinc*, etc.

2. (*Fortification.*) A bomb-proof shelter for men or provisions. *Blindage ; blinded cover.*

3. (*Harness.*) Flaps on a driving-bridle to restrain the horse from looking sideways or to the rear. A modern form of blinder only prevents the backward view. *Blinder ; blinker.*

Blind'age. 1. (*Fortification.*) *a.* A screen of wood faced with earth as a protection against fire.

b. A *mantelet.* At Sebastopol the Russians used blindages for covering their embrasures, composed of a grating of iron rods covered with canvas.

2. (*Harness.*) A hood for covering the eyes of a runaway horse, as a means of stopping him. KOEHLER'S patent has one strap which pulls a hood over the eyes and another which closes the nostrils. Another device is a choke-strap connected through the gag-loop to the driving-rein.

Blind A're-a. (*Architecture.*) A space around the basement-wall of a house to keep it dry.

Blind Ax'le. An axle which runs, but does not communicate motion. It may form the axis of a sleeve-axle. It may become a *live* axle at intervals. A *dead axle.*

Blind-block'ing. (*Bookbinding.*) The ornamentation of book-covers by pressure of an engraved or composed block with heat but without gold-leaf.

Blind Bri'dle. A bridle having attached flaps or blinds. See BLIND.

Blind Buck'ler. (*Nautical.*) A hawse-hole stopper.

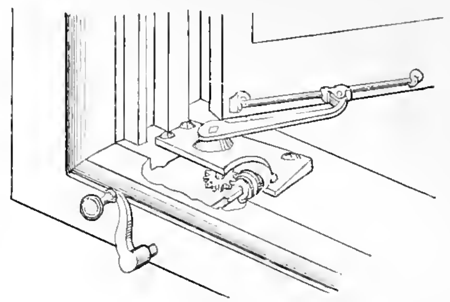
Blind'ers. (*Harness.*) Flaps over the eyes of a horse used in carriage-harness. See BLIND.

Blind'ing. A coating of sand and fine gravel, usually about an inch and a half deep, laid over a newly paved road, to fill by degrees the joints between the stones.

Blind Lev'el. (*Mining.*) A level or drainage gallery which has a vertical shaft at each end, and acts as an inverted siphon.

Blind Op'e-ra-tor. A device by which the blind may be opened or closed from the inside, and held in any position desired, either closed, fully open, or at any intermediate position, in all of which it may be securely locked. Attached to the frame of the blind is a rod upon which slides a sleeve pivoted to the outer end of an arm secured to the axis of a worm-gear seated in a recess in the window-sill and gradually rotated by a worm, the whole covered by a metallic plate.

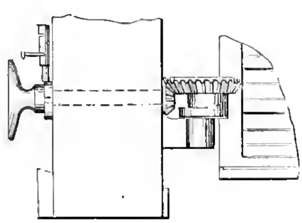
Fig. 711.



Blind and Shutter Fastener.

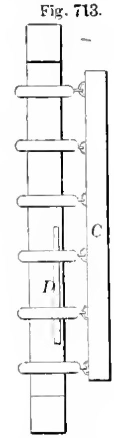
In another form, the pintle of the blind-hinge has a bevel-wheel operated by a bevel-pinion on the shaft, which passes through the frame of the window-casing, and has a knob inside the room. A bolt engages a disk on the shaft, and locks the latter, and consequently the blind, in any position.

Fig. 712.



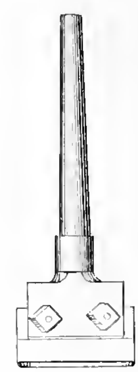
Blind-Operator.

Fig. 713.



Blind-Slat.

Fig. 714.



Blind-Slat Chisel.

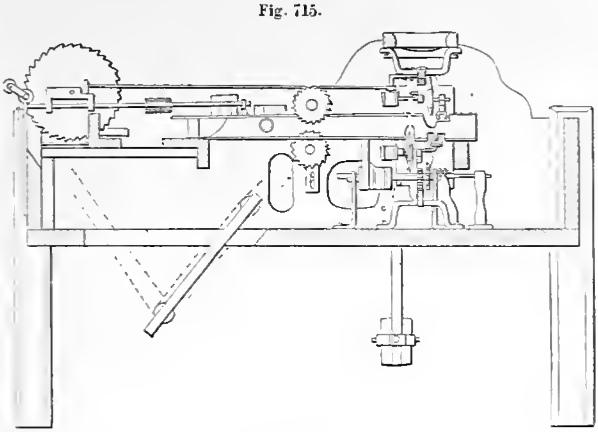
Blind-slat. An obliquely-set slat in a shutter, serving to shed rain and yet admit some light. In some cases they are adjustable by means of a bar *C*, which is secured by staples to the edges of the slats. *D* is a spring to press against the slats and hold them to adjustment. Such shutters are known as *Venetian* or *Louver.*

Blind-slat Chis'el. A hollow chisel, specially adapted for cutting the mortises in a common blind-stile for the reception of the ends of the slats.

Blind-slat Cut'ter. (*Carpentry.*) A machine which cuts blind-slats from the plank and finishes the sides and ends.

The plank is placed within the ways and fed along till it touches a stop, when a transverse cut severs a section, which is removed by a feed-roller to the place where it is sawed into strips. The action of the roller is intermittent, and during its intervals of rest the rotary tubular cutters are successively forced into the opposite sides of the block and form openings. The surfaces are planed and gudgeons made on their extremities by automatic operations.

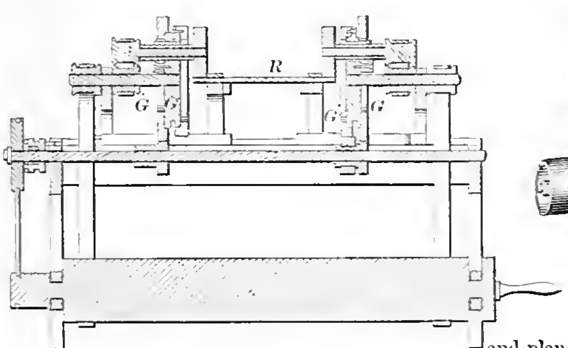
Fig. 715.



Blind-Slat Cutter.

Blind-slat Plan'er. (*Carpentry.*) A wood-planing machine with side and edge cutters adapted to act upon a narrow slat suitable for Venetian shutters and blinds. The cutter which acts upon the upper side is adjustable to adapt it for making slats of the required thickness; the edge-cutters have a shape to give the rounded edge, and one of them is adjustable as to distance, to make slats of the required width.

Fig. 716.



Blind-Slat Tenoning-Machine

There are several patented machines of this class.

Blind-slat Ten'on-ing-ma-chine'. (*Carpentry.*) A machine for cutting tenons on the ends of blind-slats where they are to enter the stiles of the blinds. (Fig. 716.)

As the disks *G* rotate, they carry around the cutter-heads, whereby a tenon is cut upon each end of the blank slat. As soon as the blank *R* is inserted, the operator, by means of a clutch, causes the cutter-heads to revolve entirely around the ends of the slat, when they are arrested until the finished blank is removed and a new blank inserted. The cutter-head, may be set towards or away from the center of the disk-shafts, in order to cut larger or smaller tenons. The cutter-heads have a rotary movement upon their own axes, and also revolve around the axes of their supporting disks.

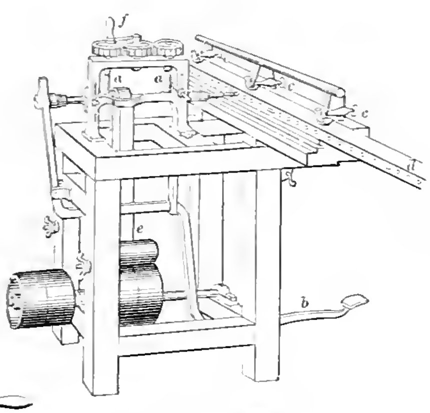
Blind-stile Bor'ing-ma-chine'. (*Carpentry.*) A machine for boring in blind-stiles the holes for the reception of the tenons on the ends of the slats.

The machine (Fig. 717) is arranged for boring one hole at a time, and is suitable for blind, sash, door stiles, wagon-work, etc. The arbor is raised or lowered by screws *a a*, and brought forward to the work by means of the lever *b*. It is provided with space-rack clamps *c c* for holding the stuff, which will gage the holes any desired distance apart, and which avoids the necessity of setting out. The tight and loose pulleys are 6½ inches in diameter, 3 inch face, and should make 625 revolutions per minute, which will give 2,500 to the bit. *e* is the belt which conveys motion to the arbor.

In the machine (Fig. 718) the bit-arbor *a* is vertical, is driven by the belt *e*, and the stuff lies on the rest. It has a pawl and ratchet arrangement for feed, dispensing with the necessity for laying out the holes. The bit is drawn down by the treadle *c*.

Blind-stile Ma-chine'. (*Carpentry.*) Machines which get out the stuff are but saws

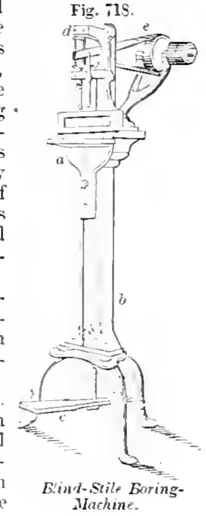
Fig. 717.



Blind-Stile Boring-Machine.

and planers; but, when the material is brought to shape, machines are adapted for boring the holes for the slats, or making the mortises by means of piercing,—that is, by a hollow chisel of the shape of the slat-section,—or making them by a chisel repeatedly reciprocated while the stuff is fed along, as in the ordinary mortising-machine. Some of the machines space as well as bore or mortise; that is, feed the stuff along the distance between slats after each stroke.

Fig. 718.



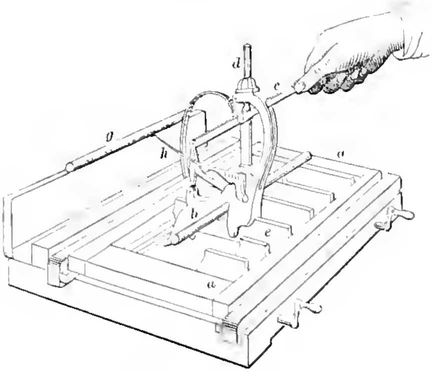
Blind-Stile Boring-Machine.

Blind-tool'ing. (*Bookbinding.*) The ornamental impressions of heated tools upon leather without the interposition of gold-leaf.

Blind-weav'ing Loom. (*Weaving.*) A loom which has its warps far apart, and an automatic device for placing within the shed the thin wooden slips which form the filling or woof. As the shed is opened, a rod with a gripper on the end is passed through the shed, catches a slip, and draws it between the warps, leaving it there. This is repeated between each movement of the harness.

Blind-wir'ing Ma-chine'. (*Carpentry.*) A machine for the insertion of the staples which connect the rod to the blind. The blind-frame *a* is held by adjustable slides, and the rod *b*, with its staples or rings already inserted, is laid along upon the slats

Fig. 719.

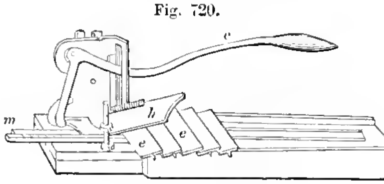


Blind-Wiring Machine.

e, the rings presented sideways. The staples to be driven straddle the wire *h* and feed down it, being driven one at a time by the lever *c* and plunger *d*, so that one leg of the staple passes through the eye on the rod *b*, and both of them enter the slat *e*. The frame is fed forward the distance between the slats after each operation.

Fig. 720 shows a somewhat similar form of machine in which the staples feed down the incline *h*, and are driven into the slats *e* as the lever *c* is de-

Fig. 720.



Crosby's Blind-Wirer.

pressed. The lifting of the lever moves forward the blind-frame by means of a pawl which engages the rack *m*.

Blink'er. (*Saddlery.*) A blind.

Blis'ter-steel. Steel formed by roasting bar-iron in contact with carbon in a cementing furnace. It is so called from its blistered appearance. To improve the quality, it is subjected to two subsequent processes, which convert it into *shear*-steel and *cast*-steel.

Block. A grooved pulley, rotating on a pintle, and mounted in a casing called a *shell*, which is furnished with a hook, eye, or strap by which it may be attached to an object. It is used for changing the direction of motion of ropes used in transmitting power, and, by compounding two or more such sheaves, to increase the mechanical power of ropes, whose rate of motion is decreased in an equivalent degree thereby.

The parts of a block are: —

The *shell*, pulley-frame, or body of the block is made of a tough wood, or sometimes of iron; it has one or two grooves, called *scores*, cut on each end to retain the *strap* which goes around it. The shell is hollow inside to receive the *sheave* or *sheaves*, and has a hole through its center to receive the sheave-pin, called the *pintle;* this is lined with bronze or gun-metal, called a *bouching* or *bushing*. When the shell is made of one piece, it is called a *mortise-block;* when more than one are employed, it is termed a *made block*. The side plates of the shell are *cheeks*.

The *sheave* or wheel is of lignum-vitæ or iron, and has a peripheral groove for the rope, called the *gorge*. It has a bushing, called a *coak*, around the pintle-hole. The space between the sheave and its block, through which the rope runs, is called the *swallow* or *channel*. It answers to the *throat* of some other machines; the *pass* in a rolling-mill.

The pin or *pintle* is the axis or axle, and is usually of iron, passing through the *bushing* of the *shell* and the *coak* of the *sheave*.

The *strap, strop, iron-binding, grommet,* or *cringle*, is a loop of iron or rope, encircling the block, and affords the means of fastening it in its place. The *hook* of iron-strapped blocks is frequently made to work in a swivel, so that the several parts of the rope forming the tackle may not become "foul" or twisted around each other.

For strapping with rope in the common way, the rope is cut 1½ times the circumference of the block, and stretched; it is then *wormed*, by winding-in spun-yarn or marline between the intervals of the strands; *pareeled*, which operation consists in winding a canvas strip around the above; and then *served* or closely wound around with marline, until just sufficient is left at each end for splicing; it is then spliced with a short splice, the fag-ends of the strands cut off, and served over the splice.

In many cases blocks are strapped with eyes or thimbles in the ends, or, instead of the loop, have a tail, as is the case with *jigger blocks;* in this case they are called *tail-blocks*.

The *purchase*-block is double-strapped, having two scores in the shell for the purpose; the rope is *wormed, parceled,* and *served*, or may be *wormed* and *parceled* only, and *spliced*. It is then doubled up so as to bring the splice at the bottom of the block. The seizing is put on the usual way, except it is crossed both ways through the double parts of the strap. The straps of these blocks are so large and stiff that a purchase should be employed to set them securely in the scores of the blocks, and bring them into their proper place.

Blocks receive names from peculiarities of structure, from their materials, uses, arrangement in the tackle, mode of connecting them to objects, etc. See under the following heads. —

Bee-block.
Block and tackle.
Buckler.
Bull's-eye.
Cat-block.
Cheek-block.
Clew-garnet block.
D-block.
Dead-eye.
Differential-block.
Double-block.
Euphroe.
Fall-block.
Fiddle-block.
Fish-block.
Fly-block.
Gin-block.
Heart-block.
Hook-block.
Iron-block.
Jack-block.
Jewel-block.
Long-tackle block.
Monkey-block.
Muffle-block.
Ninepin-block.
Pulley-block.
Purchase-block.
Quarter-block.
Ram-block.

Rouse-about block.
Running-block.
Sheave.
Shell.
Shoe-block.
Shoulder-block.
Single-block.
Sister-block.
Smeaton's block.
Snatch-block.
Spring-block.
Standing-block.
Strap-block.
Tack-block.
Tackle-block.
Tail-block.
Thick-and-thin block.
Top-block.
Treble-block.
Tye-block.
Uvrow.
Viol-block.
Waist-block.
Warping-block.

The pulley-block, with two or more sheaves, was well known to the Romans. A block with three sheaves was called *trispastos*. Tackle with two sheaves in the lower block and three in the upper one was called *pentaspastos*. The tackles were variously arranged, much as at the present day, and the derrick spars and masts were secured by guys.

A large number of obelisks were removed from Egypt to Rome, Constantinople, and Arles, and gave employment to complex and powerful tackle.

Blocks do not appear to have been known in ancient Egypt; the ropes were rove through rings.

2. (*Carpentry.*) A square piece of wood fitted in the reëntering angle formed by the meeting edges of two pieces of board. The blocks are glued at the rear and strengthen the joint.

3. (*Hat-making.*) A cylinder of wood over which a hat or bonnet is shaped in the process of manufacture.

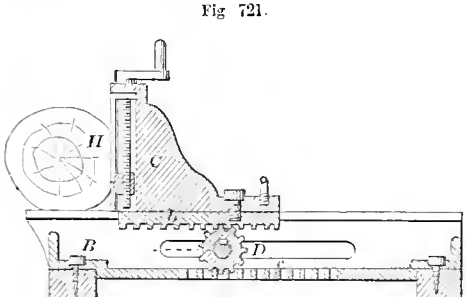
4. (*Saddlery.*) A former or block on which a piece of wet leather is molded by hammering or pressing.

5. (*Ordnance*, etc.) In the ordnance service the term *block* is applied to two different articles, which have very different functions; one kind being short pieces of scantling, used for elevating cannon and supporting them in position a short distance from the ground, or in assisting in their transfer from higher to lower levels, and *vice versa*. These are designated as whole, half, and quarter blocks, and have a uniform length of 20 and width of 8 inches, their respective thickness being 8, 4, and 2 inches.

Gin-blocks are the pulleys through which the fall of a gin is rove, and are known as single, double, or treble blocks, according as they have one, two, or three sheaves; the sheave is of brass and the shell of wrought-iron.

The varieties of blocks are more fully described under the heads enumerated in the list above.

Fig 721.



Head-Block to Saw-Mills.

6. (*Saw-mill.*) One of the frames on which an end of a log rests in a saw-mill. The log is usually set over towards the saw the thickness of one board, plus the kerf, between the cuts. In the more modern and improved form the *head* and *tail* blocks are set simultaneously. In the circular saw-mill the knees resting on the head and tail blocks are moved, pushing the log *H* on the blocks *B*, as in Fig. 721, where the knee *C* is operated by a spur pinion *D* and racks *b c*. See also CIRCULAR SAW; HEAD-BLOCK.

Block and Tack'le. A term including the block and the rope rove through it, for hoisting or obtaining a purchase. See TACKLE.

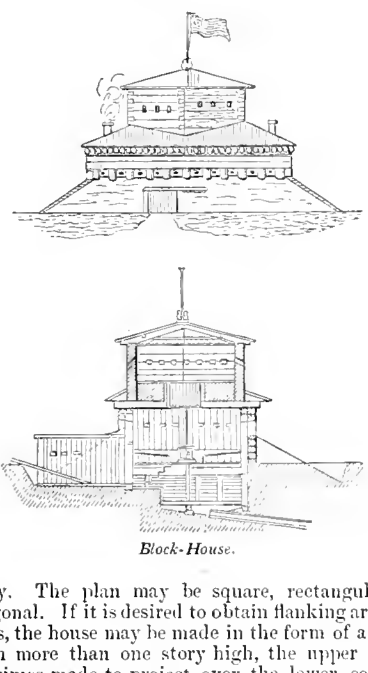
Block-book. (*Printing.*) A book whose pages are impressions from engraved blocks, each of which formed a page. This was a very old Oriental invention, and did not differ especially from the calico-printing of China, India, Arabia, and Egypt, the books and placards of China, and the printed playing-cards commonly used in Europe many years before Coster, Guttenberg, and Faust.

The great invention was *movable* types. See PRINTING.

Block-fur'nace. (*Metallurgy.*) A *blomary*.

Block-house. (*Fortification.*) A structure of heavy timber or logs for military defence, having its sides loopholed for musketry. When of large size, it may be provided with ports or embrasures for artillery.

Fig. 722



Block-House.

The plan may be square, rectangular, or polygonal. If it is desired to obtain flanking arrangements, the house may be made in the form of a cross. When more than one story high, the upper one is sometimes made to project over the lower, so as to obtain a direct downward fire. A ditch is dug around the block-house, the earth from which is thrown up around the lower part of the house; the roof may also be covered with earth.

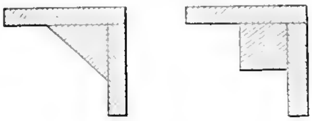
Block-in-course Ma'son-ry. (*Masonry.*) A kind which differs from ashlar masonry chiefly in being built of smaller stones. The usual depth of a course is from seven to nine inches.

Block'ing. 1. (*Leather.*) The process of bending leather for boot-fronts to the required shape. See CRIMPING.

2. (*Bookbinding.*) Impressing a pattern on a

book-cover by a plate or association of tools under pressure. It is called *blind* or gold blocking. In the latter case, gold-leaf is used; in the former, the bare block.

Fig. 723.



Blocking.

3. (*Carpentry.*) A mode of securing together the vertical angles of wood-work. *Blocks* of wood are glued in the inside angle.

Block'ing-course. (*Architecture.*) The upper course of stones or brick above a cornice or on the top of a wall.

Block'ing-down. (*Sheet-metal Working.*) Sheet-metal is *blocked down* upon a mold or shape by laying above it a thick piece of lead, which latter is struck by the mallet or hammer. This mode is sometimes adopted to bring a plate partially to shape before swaging it between the dies.

Block'ing-ket'tle. (*Hat-making.*) A hot bath in which hats are softened in the process of manufacture, so as to be drawn over *blocks*.

Block'ing-press. A bookbinder's screw-press in which blocking is performed. It has less power than the embossing-press, which operates with large dies, being used for ornamentation, requiring but a comparatively small pressure.

The die is adjusted in the upper bed (or plate), and is heated by means of gas-jets coming down through a cavity at its back. The book-covers are introduced *seriatim* upon the lower bed by the operator, who by a turn of the handle brings the upper bed down with a gentle and equable pressure, fixing the gold-leaf, when this is employed, upon the surface, previously prepared for the purpose. A boy, who assists, removes the superfluous portions with a rag, which becomes thoroughly saturated with the precious metal in the course of use, and is sold to the refiners.

Block-let'ter. (*Printing.*) Type of large size cut out of wooden blocks.

Block-let'ter Cut'ting-ma-chine'. Block-letters, or wooden type, are generally made of cherry, cut endwise. They are made of sizes from 2 or 3 line Pica up to 150-line Pica, more than two feet in length.

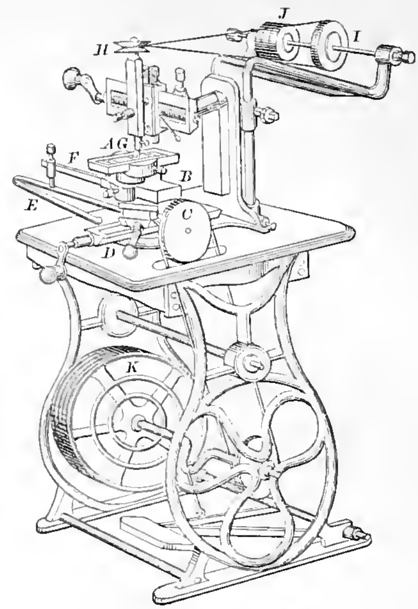
Fig. 724 illustrates a machine for cutting these types. The wood, having been carefully planed to a true surface and even thickness, is cut into blocks of suitable size, and the outlines of the letters formed as a guide in cutting. A block is placed in the chuck *A*, fixed in the slide *B*, which may be moved back and forth in a guide, and to which a rotary motion may also be imparted by means of a gear-wheel and screw operated from the pulley *C*.

Below this is another slide *D*, carrying an arm *E*, which supports an upright bar, with a rod *F* attached to the chuck *A*. Below all is a circular plate pivoted to the table, and capable of being turned in any desired position and secured there, for adjusting the work to the proper angle previous to cutting.

The cutter *G* is fixed in a spindle which is rotated by the pulleys *H I*, the latter on a shaft driven by either of the fast-pulleys at *J*, operated by a band-wheel *K* on the treadle-shaft. The box carrying the cutter-spindle has vertical adjustment for varying the depth of cut, and may also be moved laterally by a screw and crank. A lever is provided for lifting the cutter clear of the work.

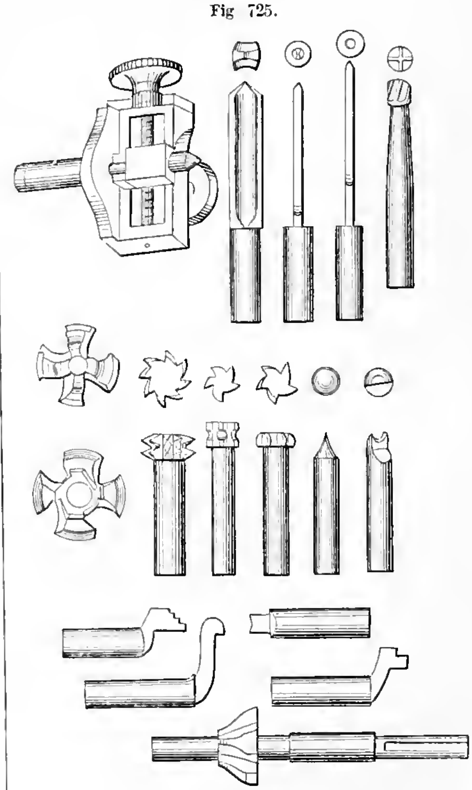
By means of the bar and rod *E*, *F*, and pulley *C*, and their connections with the slide *B* and chuck *A*, in conjunction with the slide *D*, the work may be moved in any direction, causing the cutter to produce any combination of right lines or curves.

Fig. 724.



Block-Letter Cutting-Machine.

Fig 725.



Tools for Block-Letter Cutting-Machine.

Fig. 725 shows various forms of cutters, some of which are designed for making any number of circles of uniform diameter, and others for clearing out the wood from those parts not designed to show in printing.

Block-mak′ing Ma-chine′. The first set of machinery for making blocks for tackle was the invention of the elder Brunel, and was constructed by Maudslay. The invention of " the ingenious American mechanic," as Mr. Tomlinson calls him, was endorsed by General Bentham, the Inspector-General of Naval Works, and sanctioned by the Lords of the Admiralty in a remarkably short space of time, — one year. The work on the machinery was commenced in 1802, and was finished in 1808. The machines were set up in Portsmouth Dock-yard, and a duplicate set was made for Chatham Dock-yard, to be used in case of accident, but has not been needed. For twenty-five years the machines required no essential repairs. The cost was $230,000, and the saving per annum over hand labor is variously estimated from $83,000 to $150,000. Brunel received $5 per day for superintendence, $5,000 for the working models, and a grant of $83,000 when completed.

The machines are in three different sets, fifteen in a set, for making different sizes ; each set having a certain range of adjustability as to the sizes of blocks turned out.

The different blocks made by these machines are as follows : —

Thick block, with 1, 2, 3, or 4 sheaves, and from 4 to 28 inches in length	72 sizes.
Thin blocks, 6 to 26 inches	48 "
Clew-garnet and clew-line blocks	10 "
Sister-blocks	20 "
Topsail-sheet blocks	20 "
Fiddle or viol blocks	24 "
Jack-blocks	20 "
	214 sizes.

The first set makes blocks 4 to 7 inches in length, with wooden pins, at the rate of 700 per day.

The second set makes blocks 8 to 10 inches in length, with iron pins, at the rate of 520 per day.

The third set makes blocks 11 to 18 inches in length, at the rate of 200 per day. Total, 1,420 per day.

Two machines are employed for making dead-eyes from 5 to 9 inches, and from 10 to 19 inches in diameter.

One large boring-machine, not included in the above.

Two machines for making the iron pins.

Total, 50 machines.

These machines are driven by a steam-engine of 32-horse power.

With these machines 4 men do the work of 50 in making shells, and 6 men do the work of 60 in making sheaves ; total, 10 men doing the work of 110 previously working by hand. The amount actually supplied was about 135,000 blocks per annum from 1808 to 1816. 1,500 blocks are required in rigging a ship of the line, besides dead-eyes, say 160.

The sawing-machines are employed on one side of the house to cut the elm and ash timbers into parallelopipedons of the required sizes and shapes ; and the block-making machines on the other side are employed to reduce these blocks to shape, fashioning the outside and the mortise, and to make and *coak* the sheaves.

The machines are as follows : —

1. The *reciprocating cross-cut saw*, which is used on large timber to cut into lengths timber of large size.

2. A *circular cross-cut saw*, for operating on timbers of smaller diameter.

3. The *reciprocating ripping-saw*, for cutting the *juggles*, or cylindrical blocks of timber, into parallelopipedons of the required proportions.

4. The *circular ripping-saw*, for performing the same operation on small timber.

5. The *boring-machine*, for boring a hole through the shell to start the mortise, and boring the hole for the pintle. See Boring-machine.

6. The *mortising-machine*, which completes the hollowing out of the shell, making the full opening for the sheaves. See Mortising-machine.

7. The *corner-saw*, to bring the shell to an approximate shape, ready for the next machine. See Corner-saw.

8. The *shaping-machine*, which turns the outside of the shell to form. See Shaping-machine.

9. The *scoring-machine*, which cuts the scores on the shell for the reception of the straps by which it is slung. See Scoring-machine.

This completes the dressing of the *shells* of the blocks, except some smoothing where the wood is roughed up in dressing.

10. For making the sheaves three kinds of saws are employed. A *reciprocating saw* is used for making disks of wood by cross-cutting lignum-vitæ logs. A *circular saw* is used for cross-cutting smaller logs. A *crown-saw* and center-bit are used for rounding the sheaves and boring the center-hole.

11. The *coaking-machine* cuts three semicircular cavities at equal distances around the hole made by the bit. This cavity is for the reception of the coak or bush of bell-metal, which forms a socket for the center-pin.

12. A *drilling-machine*, for perforating the three semicircular projections of the coak for the reception of short wire pins or rivets, by which the coak is attached to the sheave.

13. A *riveting-machine ;* two small tilt-hammers for riveting the wires which hold the coaks in their places.

14. A *broaching-engine*, which reams out the center-hole.

15. A facing-lathe turns the flat sides of the sheaves and makes the groove in the periphery.

The iron center-pins are turned in a lathe, and then polished by being fixed in a vertical revolving axle, and forced down into a die immersed in oil, and hold three pieces of hard steel, between which the pin is pressed as it turns, and becomes completely polished.

Block-print′ing. A mode of printing cotton cloth or paper for hangings, in which the pattern is engraved in relief upon a block, which is dabbed upon the color and impressed by hand upon the material, which lies upon a table before the workman. When the pattern is in several colors, different blocks of the same size are employed, the raised pattern in each being adapted for its special portion of the design. The exact correspondence of each part, as to position, is secured by pins on the blocks, which pierce small holes in the material and indicate the exact position. This is a registering system similar to that adopted in chromatic printing, and in all forms of lithographic printing in which more than one color is used.

This mode of printing was nearly superseded by the system of Perrot, in which the calico passed between a square prism and three engraved blocks, which were brought in apposition to three faces of the prism, and delivered their separate impressions thereupon in succession. Each block was inked after each impression, and the cloth was drawn through by a winding cylinder. The blocks were pressed against the cloth by springs. This was a great improvement upon block-printing, being nearly twenty times as rapid; but the cylinder or roller printing has outstripped them both, performing as much labor as 100 block-printers. See CALICO-PRINTING.

Block-teeth. (*Dental.*) Two or more teeth made in a block carved by hand from ivory, whale's or walrus's teeth, etc.

Block-tin. Tin cast into ingots.

Blom'a-ry. (*Metallurgy.*) The first forge through which iron is passed. The pig-iron, having been puddled and balled, is brought to the hammer or squeezer, which makes it into a *bloom*. *Bloomary.*

Blond-lace. A silk lace of two threads twisted and formed in hexagonal meshes.

Bloom. 1. (*Metallurgy.*) A loop or ball of puddled iron deprived of its dross by shingling or squeezing.

2. (*Leather Manufacture.*) A yellowish powdery coating on the surface of well-tanned leather, by which its quality is adjudged. It may arise from a deposit of surplus tannin, and thus be an indication that the process is fully accomplished. Oak-bark tanning yields the best *bloom*, and some of the quick processes none at all.

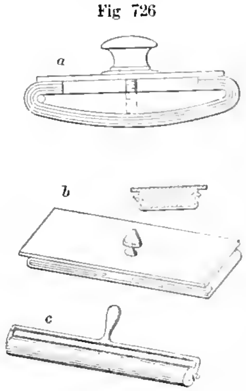
Bloom'er-pit. A tan-pit in which hides are subjected to the action of *strong* ooze. So called because the conclusion of the process brings a *bloom* on the skin. Also called a *layer*.

The pits containing a weaker solution are called *handlers*.

Bloom-hook. (*Metallurgy.*) A tool for handling the heated bloom, drawing it towards the shingler, moving it under the hammer, etc. *Bloom-tongs.*

Blot'ter. A device for absorbing the superfluous ink from paper after writing. The blotter may be merely a thin book interleaved with bibulous paper, or a pad or cushion covered with blotting-paper, *a* or *b*, and having a handle, being used after the manner of a stamp. Another form consists of a roller *c* covered with successive layers of blotting-paper, and revolving on an axis, a handle being attached for convenient use. The layers of paper may be removed as they become soiled, and fresh paper substituted.

Fig 726



Blotters.

Blot'ting-pad. A few sheets of blotting-paper on the writing-table or desk, to form a soft bed for the writing-paper.

Blot'ting-pa'per. A thick, bibulous, unsized paper, used as a pad on the desk or to imbibe superfluous ink from undried manuscripts.

Blow'er. A machine for creating an artificial current of air by pressure. A *plenum* engine, as contradistinguished from a *vacuum* engine, such as an *aspirator*.

1. Blowers are used to increase drafts in furnaces; to furnish vital air to close and fetid places, as mines, wells, cisterns, holds of ships, etc.; to furnish a current of warmed, cooled, moistened, or medicated air to public buildings or others which are liable to be closely occupied; to furnish a drying atmosphere in lumber, grain, or meal kilns, powder-mills, etc.; to assist in evaporating fluids by removing the steam from the vicinity of the boiling syrup or other solution; to raise fluids on the principle of the Giffard injector, as in some of the ejectors used in deep oil-wells; to assist in the dispersion of liquids, as in atomizers, and some ice-making machines.

The fan-blower is believed to have been invented by Teral, 1729. The water-bellows by Hornblower.

Blowing-machines were erected by Smeaton at the Carron Iron Works, 1760.

The hot-air blast was invented by James Neilson, of Glasgow, and patented in 1828.

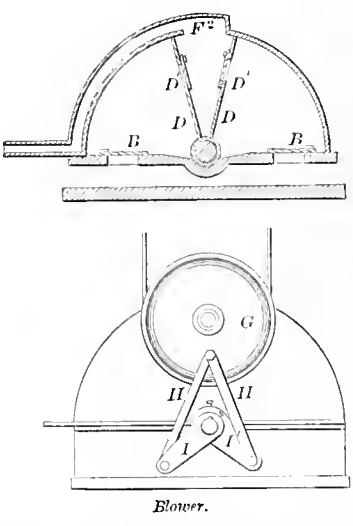
Wooden bellows, in which one open-ended box is made to slip within another, with valves for the induction and eduction of air, were used at Nuremberg, 1550. They were used in the next century for smelting, blacksmithing, and for organs. Such a machine is in principle the same as Fig. 106, and the converse of that shown in Fig. 114.

P. Fannenschmid of Thuringia appears to have made, about 1621, a much more effective blower than was previously used by the metallurgists of his section. This was a flat vane reciprocating in a sector-shaped box and having an inlet valve for the air. At the hinging-point of the vane, the edge of the sector, an eduction pipe proceeds from the box. Slips of wood on the edge of the vane were pressed against the sides of the box, to prevent the leakage of air.

Somewhat similar to this is the oscillating or pulsating piston (Fig. 727).

The fans D D' are oscillated in a semi-cylindrical case with an upper exit at F^2, and two valves B B

Fig. 727.

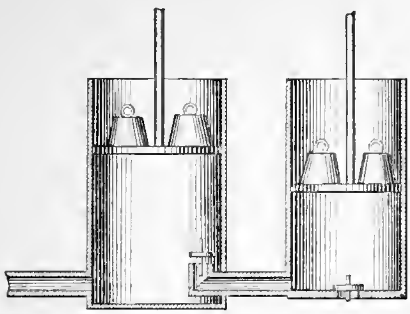


Blower.

opening upwardly; the fans have also valves opening towards each other. The alternate oscillating motion of the fans is produced by crank connection H I with a driven pulley G.

The earlier modern forms of machine-blowers consist of cylinders with pistons, the differences between them consisting principally in the means for communicating motion and for securing a uniform blast; an arrangement for this purpose is shown in the figure, consisting of two connected cylinders, one of them provided with a discharge-pipe; by the descent of the piston in the first cylinder the air is forced into the other cylinder through a valve which rises to allow its passage. At the same time the piston of the second cylinder is caused to rise, and, on reaching its highest point, commences its descending motion, closing the communicating valve and forcing the air through the discharge-pipe, while the first piston rises, filling its cylinder with air, to be similarly forced into the second cylinder, and thence expelled as before.

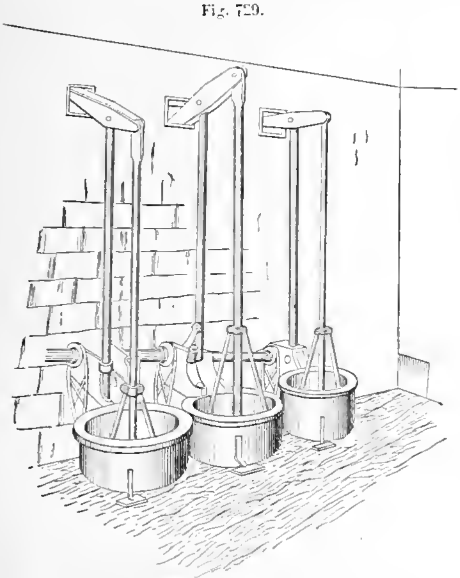
Fig. 728.



Piston-Blower

In other forms of blowing apparatus on this principle, the air is forced from the blowing cylinders into a reservoir, whence it issues by the force of its compression. Such is that used at Woolwich, England (shown in Fig. 729). The beams of the pistons are so connected that when one is at the top of the stroke another is midway of its cylinder and the third at its lowest point, maintaining very nearly uniform pressure in a wind-chest below with which each cylinder communicates.

Fig. 729.



Woolwich Blowers.

Blowers on the fan principle are the favorite subjects of the exercise of the ingenuity of modern inventors in this line.

In these the air is admitted through an aperture at or near the axis of the rotating fan, whence it is driven toward the periphery by means of curved arms, and discharged through an opening in the case.

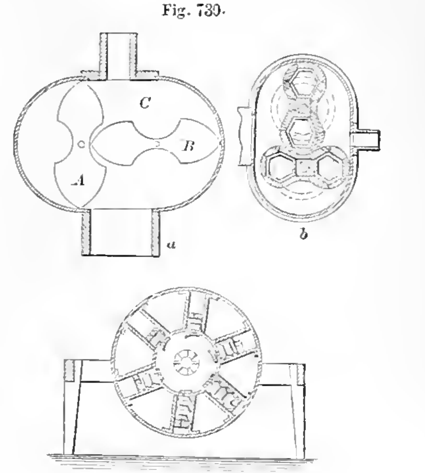
In Schiele's compound blowing-fan, two fans are combined on the same shaft, so as to act successively on the same air. By the first the air is driven into a chamber between the fans, at a pressure of perhaps six ounces. The second receives the air at this pressure and compresses it as much more, so that it is delivered at length into the furnace at a pressure of twelve ounces per square inch.

Lloyd's noiseless fan consists of a drum formed of two flat hollow cones of thin metal, brought near together by their bases, and connected by a series of curved partitions extending from the center to the circumference. The cones are open about the vertexes, and an axis of revolution supports the whole by being the common origin of all the curved partitions. This drum rotates within a closed box, and discharges the air received at the center through a tangential outlet. See FAN.

Other rotary blowers are on the principle of the rotary pump or rotary engine, having two portions which revolve in apposition.

In Fig. 730, *a* represents a blowing-machine having two similarly shaped elongated cams *A B*, the projections of each of which fit into the depressions of the other. These are arranged in a suitably shaped box *C*, and driven by pitmen so arranged that portions of the periphery of each blower shall be constantly in close proximity, while the two ends or wings of each move in proximity to the curved sides of the box. The rotation of the two blowers in opposite directions draws the air through an opening in one side of the box, and forcibly discharges it through a blast-pipe at the other.

Fig. 730.



Rotary Blowers.

Root's blower, *b*, is similar in principle to the foregoing; the projections of the cams are, however, rounded off so as to form circular arcs, while the depth of the depressions is decreased, causing a longer lap on the abutting surfaces, so as to provide against the escape of air in the wrong direction.

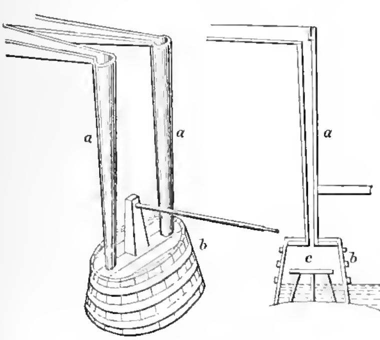
In *c* a series of bellows, provided with suitable valves, are radially arranged around a tube surrounding the axis of a wheel. A heavy block moving in guides descends by gravity on approaching a vertical position, admitting air during the lower part and forcing it out through the central tube during the upper part of the revolution.

Blowers have been made having an eccentric drum, with radial pistons or valves, which rotates within an exterior casing; or the interior of the case may be itself eccentric and the drum central on its shaft,— the pistons, in either case, being reciprocated alternately back and forth in slots in the drum, as that portion of its periphery in which they are situated approaches or recedes from the side of the casing.

The principle of the rotary pump is entirely applicable to the blower, and a machine of this kind which causes a current of water to ascend may be made to create a blast of air.

The *hydrostatic bellows* is formed by a body of water falling through a pipe or pipes *a a*, pierced with

Fig. 731.



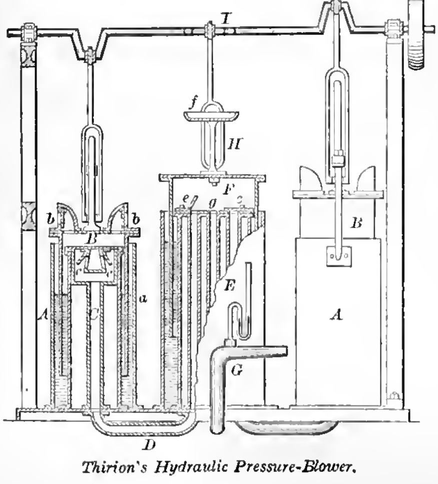
Hydrostatic Bellows.

a number of holes inclined inwardly and downwardly. The current of water draws air in at these orifices, and carries it down into the chamber *b* below, where it is compressed, and, separating from the water, rises into a trunk on the upper part of the chamber, whence it is conducted by a pipe to the forge. The water dashes upon a table *c* in the chamber, which assists in the separation of the air, and then escapes by a trap beneath the water-level. The force of the blast is proportionate to the volume and fall of the water, and is regulated by a sluice.

Thirion's hydraulic pressure-blower is termed by him *machine soufflante à colonne d'eau.* The water is, however, merely employed to pack the working parts and prevent friction.

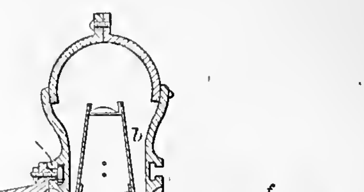
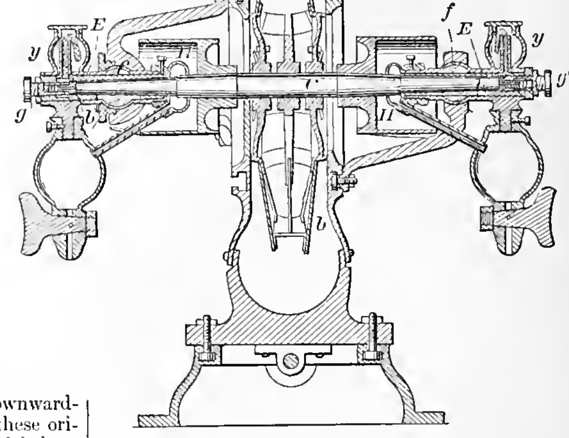
A A are two compressing cylinders having inner and outer walls, the space between which is filled with water up to a certain level, as *a*. *B B* are cylinders which are reciprocated within this annular

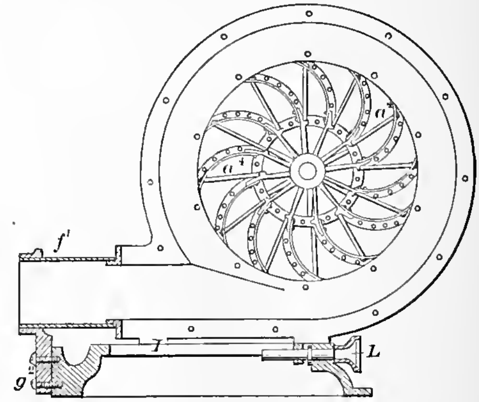
Fig. 732.



Thirion's Hydraulic Pressure-Blower.

Fig. 733.



Sturtevant's Blower.

space by a driven pulley and cranked shaft *I*. The regulator comprises an annular outer cylinder *E* and an interior cylinder *F*. The outer cylinder is partially filled with water, and the inner has a vertical motion therein, limited by the guide *H* rigidly suspended from the shaft *I*.

The upward movement of either cylinder *B* admits air through the valves *b*, which is forced by the downward movement through the valves *c c* in the enlarged portion of the pipe *C D*, into the upper cylinder *F* of the regulator, through the valves *c c*. The weight of the cylinder *F* forces the air into the central tube *g*, which forms the upper part of the blast-pipe *G*, under an amount of pressure regulated by weights in the scale-pan *f* fixed on the top of the guide-rod of the cylinder.

Sturtevant's blower has spoked wheels, having conical annular disks mounted on an axis driven by two belts to prevent tendency to wabbling. The air enters between the spokes around the axis, and is driven forcibly by the curved floats which span the space between the annular disks, being discharged into the peripheral receiving-chamber *A*, whence it reaches the horizontal eduction-pipe shown in the lower part of the figure. Within each of the band-pulleys is an oil-collector *H*, which intercepts superfluous oil and conducts it to the oil-chamber *l*, whence it may be drawn by a faucet. The shaft *C* is supported in tubular bearings at *E E*, sustained in brackets by means of ball-joints *f*, whereby the bearings are able to accommodate themselves to the shaft while in revolution. The oilers *g* for the journal of the shaft *C* are near the end, and have dripping wicks which feed the lubricant in regular quantity; the oil-collectors *H* intercepting any superfluity, as already stated. The set screws *g g'* afford means for adjusting the shaft *C* lengthwise, so as to bring the wheel to its proper position in the case.

Another form of blower, if the term be admissible, is a steam-jet, which induces a current by producing a partial vacuum. It is used in providing the vacuum in front of the traveling-carriage of a pneumatic tube, a jet of steam issuing from an annular nozzle concentric with that end of the tube toward which the carriage is moving. The steam or vapor carries along with it a current of air which is drawn from the tube. It is more correct to call this a substitute for the *blower*.

The steam-jet for the ventilation of mines was used long ago, and then abandoned. It has since been tried very successfully at a colliery at Oldham, England, in which the satisfactory flow of nearly 23,000 cubic feet of air per minute was obtained.

2. An iron plate temporarily placed in front of an open fire, to urge the combustion.

3. A machine for separating the hair from the fur fibers. See BLOWING-MACHINE.

Blow'er and Spread'er. (*Cotton-Manufacture.*) A machine for spreading cotton into a lap, the action of beaters and blower being conjoined for the purpose. See COTTON-CLEANING MACHINE.

Blow-gun. Used by the Barbados Indians of Brazil and other aborigines of South America. A similar contrivance is employed by some of the Malays, by whom it is called "sumpitan." The arrows are about fifty inches long, made of a yellow reed and tipped with hard wood, which has a spike of cocourite wood poisoned. The spike is cut half through, so as to break off in the wound, that the arrow-shaft may drop and be recovered. See AIR-GUN.

Blow'ing-cyl'in-der. (*Pneumatics.*) A form of *blowing-engine.*

Smeaton introduced the blowing-cylinders at the Carron iron-works, and by the power and volume of blast made effective the earnest and repeated attempts of the English to smelt iron by the use of the coke of pit-coal. This was in 1760, and utilized the invention of Abraham Darby, of Colebrookdale, in 1735.

Blow'ing-en'gine. Properly, one applied to the duty of driving a blower; sometimes it is intended to mean a machine by which an artificial draft by *plenum* is obtained. For such, see BLOWER.

Blow'ing-fur'nace. (*Glass-making.*) A furnace in which articles of glass in process of manufacture are held to soften, when they have lost their plasticity by cooling.

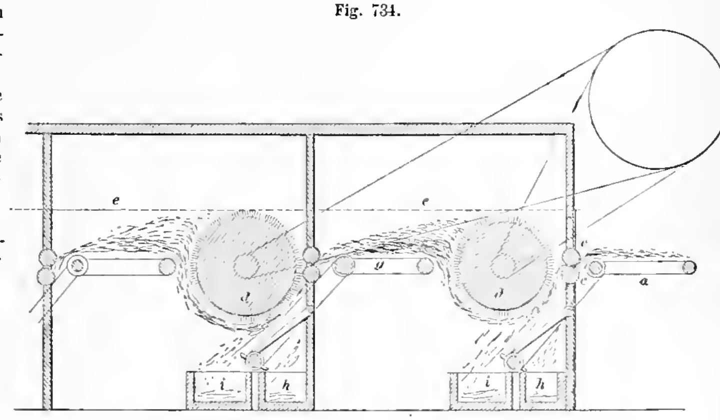
Blow'ing-pipe. (*Glass-making.*) The glass-blower's pipe; *bunting-iron*; a *pontil.*

Blow'ing-ma-chine'. 1. One for creating an artificial draft by forcing air. See BLOWER.

2. (*Hat-making.*) A machine for separating the "kemps" or hairs from the fur fibers. The fibers are fed from an endless apron between rolls to a revolving picker in a closed chamber, which tosses the mass upwards against a horizontal gauze partition, through which the air escapes, whence they fall on to a second apron, which carries them to a second chamber, where this operation is repeated. The coarse and heavier hairs fall by their gravity into boxes in the bottom of the chamber. The operation twice or thrice repeated completes the separation, when the fur is ready for the forming-machine which makes the bat for felting.

Fig. 734 represents the ordinary fur blowing-machine.

Fig. 734.



Blowing-Machine.

The mixed fur and hair is placed on the endless apron *a*, and is fed into the rollers *c c*, which feed the rotating-picker *d*. This separates it, and tosses the mass up toward the wire-gauze screen *e*, which allows the air to escape, and causes the mass to fall on the second endless apron *g*, which carries it into the second apartment. While the disintegrated mass of fur has thus been passing through the first apartment, the heaviest and coarsest hairs and the dust have by reason of their weight fallen into the boxes *h i*.

The mass, on passing into the second apartment, is treated in a precisely similar way, and is usually conducted from thence into a third apartment, where it is operated on in the same way, and finally delivered in a fit state for manufacture.

3. (*Cotton-Manufacture.*) A part of the batting-machine, or a machine in which cotton loosened by willowing and scutching, one or both, is subjected to

a draft of air occasioned by a fan, which removes the dust and other light small refuse from the fiber. See BATTING-MACHINE.

Blow'ing-off. (*Steam-Engine.*) The process of ejecting the super-salted water from the boiler, in order to prevent the deposition of scale or salt.

Blow'ing-pot. (*Pottery.*) A pot of colored slip for the ornamentation of pottery while in the lathe. The pot has a tube, at which the mouth of the workman is placed, and a spout like a quill, at which the slip exudes under the pressure of the breath. The ware is rotated in the lathe, while the hollows previously made in the ware to receive the slip are thus filled up. Excess of slip is removed, after a certain amount of drying, by a spatula or knife, known as a *tournasin.*

Blow'ing-through. (*Steam-Engine.*) The process of clearing the engine of air by blowing steam through the cylinder, valves, and condenser before starting.

Blow'ing-tube. (*Glass-making.*) *Ponty; Pontil.* An iron tube from four to five feet in length, and with a bore, according to the character of the work, of from one third to one inch in diameter. The *metal*, as the molten glass is called, is gathered on the larger end, which is thrust into the glass-pot, and the mouth is applied to the smaller end to blow the glass, making it hollow by a body of air; the shape of the object being determined by swinging, by rolling on the *marver*, by tongs, and other tools. See GLASS-BLOWING.

Blow-off Cock. (*Steam-Engine.*) A faucet in a steam-boiler for allowing a quantity of water to escape, to rid the boiler of mud; or, in marine engines, of a strong solution of salt.

Blow-off Pipe. (*Steam-Engine.*) A pipe at the lower part of a steam-boiler by which sediment is driven out occasionally.

Blow-o'ver. (*Glass.*) An arrangement in blowing glass bottles or jars in molds in which the surplus glass is collected in a chamber above the lip of the vessel with but a thin connecting portion, so that the surplus is readily broken off without danger to the vessel itself.

Blow-pipe. A tube through which a current of air is forced, in order to direct a flame and concentrate its heat at a particular spot.

The origin of this instrument is unknown, though it is undoubtedly of very great antiquity.

Among the earliest illustrations of metallurgic operations may be cited the little furnace with cheeks to concentrate the heat upon the crucible, and the fire urged by the blow-pipe. There seems to be a purpose to direct the flame upon the crucible in the manner of a blow-pipe; for the blast-furnace and foot-bellows were well known at that time, and are shown in the ancient paintings of Kourna, Thebes.

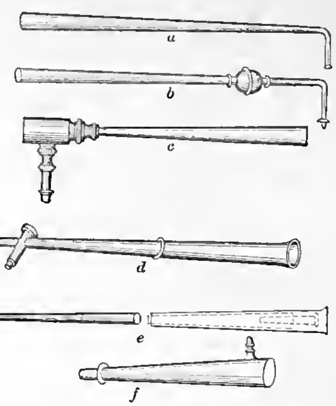
Fig. 735.

Blow-Pipe (Thebes).

The blow-pipe is used by goldsmiths, jewelers, and others, in soldering of metals, and by glass-blowers in sealing glass tubes.

It is made of various forms for special uses.

Fig. 736.



Blow-Pipes.

a. Common or simplest form of blow-pipe.

b. Two-part blow-pipe having a bulb near the small end, composed of two hemispheres in which the moisture from the breath is condensed, and which may be unscrewed for convenience of carrying in the pocket.

c. Gahn's blow-pipe made in four separable parts.

d. Wollaston's blow-pipe ready for use.

e. Wollaston's blow-pipe with its lower end and beak slid in for carriage in the pocket.

f. Dr. Black's blow-pipe. The smaller end is the mouth-piece, and the larger condenses the moisture.

While the use of the blow-pipe dates from distant antiquity, yet its use in mineralogy, in determining the nature of the metals in ores, dates from Antony von Suab in 1738, and Cronstedt, 20 years later. The subject may be satisfactorily pursued in "Plattner on the Blow-pipe," and by consulting a late work, "System of Instruction in the practical Use of the Blow-pipe."

The *reducing* flame is produced by blowing the flame of the lamp aside by a weak current of air impinging on the outer surface, the flame being unchanged except in direction. Unconsumed carbon, at a white heat, giving the yellow color to the flame, aids in the reduction of the substance.

The *oxidizing* flame is formed by blowing a strong current into the interior of the flame, perfecting the combustion. The object, being intensely heated, and exposed to the surrounding air, becomes oxidized.

In Fig. 737 is shown an apparatus charging the air-chamber by mechanical means instead of by the breath. Such devices are now much used by jewelers, mechanical dentists, and in certain departments of analytical chemistry.

It consists of a table having a chamber into which air is forced by a pump 2, operated by a treadle 5, maintaining a continuous blast through the pipe 3, to which is attached a flexible tube, enabling the flame of the lamp 4, on the table, to be thrown in any direction.

The compound or oxyhydrogen blow-pipe, invented by Dr. Robert Hare, of Philadelphia, in the early part of the present century, surpasses, in the intensity of the heat it produces, anything that had previously been attained. The flame is formed by unit-

Fig. 737.

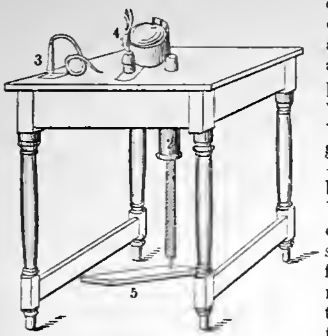


Table Blow-Pipe.

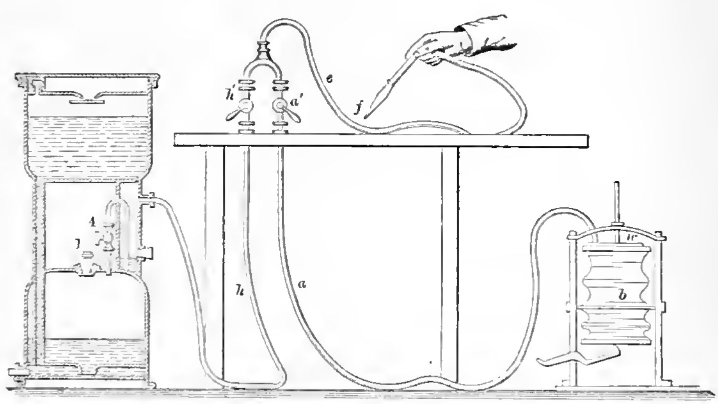
ing the two gases, oxygen and hydrogen, from separate reservoirs in a single jet, in the proportion to form water, — namely, 2 volumes of hydrogen, 1 of oxygen, — the compound being ignited just beyond their point of mixture. No substances are found capable of resisting the high temperature obtained by this blow-pipe. Carbonate of magnesia is very difficult to melt, but even this is reduced into grains of enamel of sufficient hardness to scratch glass. Platinum melts instantly, and gold in contact with borax is entirely volatilized. Pure lime and its compounds emit a flame of amethystine tinge as they melt. Quartz crystal melts with a beautiful light; pieces of china-ware are fused into crystals, and flints produce transparent glass. The intensity of the light emitted in fusing pure lime caused this invention to be recommended by Lieutenant Drummond, of the British Engineers, as an illumination for lighthouses, and it is now known as the Drummond light. Dr. Hare used an instrument terminating in fifteen jet pipes of platinum. These were adjusted so as to pass through a vessel filled with ice or snow, to prevent the gases becoming heated, and obviate the danger of an explosion by a retrocession of the flame into a single pipe. Dr. Clarke, of Cambridge, England, inclosed in the pipe containing the two gases a great number of layers of fine wire gauze, to prevent explosion; though his experiments were successful in a scientific view, the apparatus proved too dangerous for common use. M. Goldsworthy Gurney contrived an instrument in which the gases were forced from their reservoirs through a tube to the bottom of a chamber containing water, the gas rising through the water and passing immediately to the burner; a stiff pasteboard cap closely covered the reservoir, sufficiently strong to retain the gas, which, in case of an explosion, would be easily thrown off, and retrocession of the flame into the gas-chamber prevented by the volume of water. A bottle or flask half filled with mercury or oil of turpentine, connecting by leaden tubes between the reservoir and jet, like the arrangement of a Woulf's bottle, has also been used to prevent explosion. The gas rises in bubbles through the contents of the bottle or flask, and in case of an explosion retrocession of flame is prevented, either by the mercury being driven into the pipe, forming a mechanical obstruction, or in case of an explosion on the surface of the turpentine, a non-explosive compound is formed by the excess of carbonaceous matter, rendering it impossible for the flame to reach the reservoir.

The *airo-hydrogen* blow-pipe is a modification of the oxyhydrogen blow-pipe invented by Dr. Hare, of Philadelphia; the modification being the invention of Count de Richmont, of France.

The elastic tube *h* supplies hydrogen from the generator, and the pipe *a* supplies atmospheric air from the small pair of double bellows *b*, worked by the foot of the operator and compressed by a constant weight *w*. The two pipes meet at the arch and proceed by a third pipe *e* to the small jet *f*, from whence proceeds the flame. All the connections are by elastic tubes. In using the machine, the hydrogen is ignited and the size of the flame regulated by the stop-cock *h'*; the air is then admitted through *a'* until the flame assumes a fine pointed character, with which the work is united after the general manner of blow-pipe soldering, except that a strip of lead is used instead of solder, and generally without any flux. See BURNING.

The gas-generator is charged through the stopper-hole 1 with curly shreds of sheet zinc, and the stopper replaced. The pipe of communication between the upper and lower chambers being plugged or closed by a leaden stop-cock, the upper chamber is charged with dilute sulphuric acid (1 acid, 6 water). As the acidulated water reaches the zinc, hydrogen gas is evolved by the decomposition of the water, and passes off by cocks 4 and *h'*. When the outflow ceases by the closure of cocks 4 and *h'*, gas generated fills the chamber, and, pressing on the surface of the liquid in chamber 1, drives it into the upper chamber, so that the evolution of gas is stopped. When gas is withdrawn, the liquid returns and the production of gas is resumed. The generator chambers are of lead, to preserve them from the action of the acid.

Fig. 738.



Airo-Hydrogen Blow-Pipe.

In the oxyhydrogen blow-pipe, oxygen 1 volume and hydrogen 2 volumes are united in proportions to constitute water. In the airo-hydrogen blow-pipe the same gases are in the same proportions, but the oxygen is, so to speak, diluted by four times its bulk of nitrogen.

Blow-through Valve. (*Steam-Engine.*) A valve commanding the opening through which boiler-steam is admitted to a condensing steam-engine to *blow through* and expel air and condensed water, which depart through the way of the *snifting-valve.*

This is the first operation in starting an engine of this character, the condenser being then brought into operation to condense the vaporous contents of the cylinder and make the first stroke.

Blow-tube. 1. The hollow iron rod used by glass-makers to gather *metal* (melted glass) from the pots, to blow and form it into the desired shape. A *ponty*. (Fr. *pontil.*)

2. A tube through which arrows are driven by the breath. See BLOW-GUN; AIR-GUN.

Blow-up Pan. (*Sugar-Machinery.*) A pan used in dissolving raw sugar preparatory to the process of refining. Steam is introduced by means of pipes coiled round within the vessels to dissolve the sugar, which thence becomes a dark, thick, viscous liquid; a small portion of lime-water is admitted to the sugar, and constant stirring with long slender rods assists the process of liquefaction. The blow-up pans are generally rectangular, 6 or 7 feet long, 3 or 4 feet wide, and 3 feet deep, with perforated copper pipes near the bottom, though the holes of which steam is blown into the sugar.

Blow-valve. (*Steam-Engine.*) The valve by which the air expelled from the cylinder escapes from the condenser on the downward stroke of the piston when a steam-engine is first set in motion. The *snifting-valve*.

Blub'ber-guy. (*Nautical.*) A rope stretched between the mainmast and foremast heads, and serving for the suspension of the *speck-purchase* used in *flensing* whales under the orders of the *specktioneer*.

Blub'ber-spade. (*Nautical.*) A keen-edged, spade-like knife, attached to a pole, used by whalemen in removing the layer of fat or blubber which encases the body of a whale.

The carcass, stripped of the blubber, is called *krang*.

Blue-light. A signal light burning with a steady blue color.

Blue-lights are made of a composition of 9 lbs. 10 oz. saltpeter, 2 lbs. 6½ oz. sulphur, 11 oz. red orpiment. The materials are well pulverized and thoroughly incorporated, and a sufficient quantity for a charge is pressed into a hemispherical cup of seasoned wood, having a handle about ten inches long. These cups are covered with cartridge-paper pasted over the mouth, and are primed with quickmatch. When lighted, they are held by the handle until the composition burns out.

Blue-met'al. (*Metallurgy.*) One condition of copper in course of refining. The names *coarse-metal*, *fine* or *blue metal*, *coarse copper*, and *rose-copper* occur in that order. See COPPER.

Blu'ing. 1. (*Metal-working.*) The process of heating steel until it assumes a blue color. See TEMPERING.

2. (*Dyeing.*) Coloring goods by a solution of indigo.

Blun'der-bus. A short gun with a large bore, for carrying a large charge of balls and slugs, to be used at close quarters. In former times, the same body of troops seem to have been armed part with carbines and part with blunderbusses (Dutch, *donderbus*, thunder-gun). It is now disused, and we seldom hear of it except in accounts of old houses and mansions where it is provided against burglars. This is a mere reminiscence, and has no practical bearing upon the modern armorer's art.

Blung'ing. (*Pottery.*) The process of mixing clays for the manufacture of porcelain. The proper proportions of the clays and the needful quantity of water are placed over night in a trough about 2½ feet deep. The ingredients are intimately mixed by the *blunger* (corrupted from *plunger*), which is a long blade shaped like a spatula, but larger than a shovel, and having a cross-handle by which it is wielded. The material is mixed till it becomes a smooth and plastic mass, a pint of which weighs from 24 to 26 ounces, according to the ingredients.

The work is sometimes done in a pug-mill, which saves very hard manual labor.

Blunk. (*Fabric.*) A heavy cotton Scotch cloth.

Blunt-file. A file which has but slight taper. It is a grade between the regular *taper* and the *dead-parallel* files.

Blunt-hook. (*Surgery.*) An obstetric hook for withdrawing the fœtus without piercing or tearing.

Blunts. A grade of sewing-needles whose pointed ends are less finely attenuated than the *sharps*. *Betweens* are a middle grade in this respect.

Board. 1. (*Wood-working.*) *a.* A sawed piece of wood, relatively broad, long, and thin, exceeding 4½ inches in width and less than 2½ inches in thickness. The term *plank* is properly applied to a grade thicker than *boards*, though the two terms are often used indiscriminately. What in shipwrighting, etc., are called plank, would in house-carpentry usually come under the denomination of *scantling*.

According to the British system, fir-boards under nine inches in breadth are called *deals*, and boards of greater width *planks*.

b. A rived slab of wood; as, a *clapboard*.

The following terms obtain: —

Feather-edged; one edge thinner than the other.

Listed; the sap-wood removed.

Edge-shot; the edge planed.

Wrought; planed on the side.

Matched; tongued and grooved.

Jointed; lined and edge-planed so as to come together correctly.

2. A flat piece of plank or a surface composed of several pieces, used in many trades; as, —

Modeling-board; a templet having the profile of the gun or cylinder formed by the loam-molding process.

Follow-board; a supporting-board on which a pattern lies in molding.

Molding-board; flask-board on which the box is placed in sand-molding.

Dead-head board, cascabel-board, back-board, molding-out board, are also used in loam-molding operations.

3. (*Paper.*) A thick paper, composed of several layers pasted together; *pasteboard*. There are various terms employed to express different varieties.

a. Cardboard is made of thicknesses of more common paper pasted together, and having a fine quality for surfaces.

b. Bristol-board has fine paper throughout its substance.

c. Mill-board is made of coarse material, with a glossy surface produced by heavy rolling.

d. Enameled-board has a coating of white lead or other pigment.

e. Glazed board has a smooth glazed surface.

f. Tar-board is made of junk and rope.

g. Straw-board is a yet poorer quality, made of straw-paper.

h. Pressing-boards; very hard and smooth calendered boards, between which printed sheets are pressed.

4. (*Bookbinding.*) *a.* A flat slab of wood used by bookbinders. They are known by names indicating their purpose; as, backing, burnishing, cutting, gilding boards, etc.

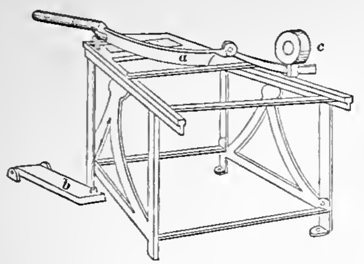
b. Pasteboard sides for books.

5. A level table or platform on which a game is

played; as, chess, checker, backgammon, cribbage boards.

Board-cut'ting Knife. (*Bookbinding.*) A hinged knife *a* with a counter-weight *c*, and a treadle *b* to assist in making the cut. The board or pile of boards is laid upon the table and pushed up against the gage, which is set for the width of the pieces to be cut.

Fig. 739.



Board-Cutting Knife.

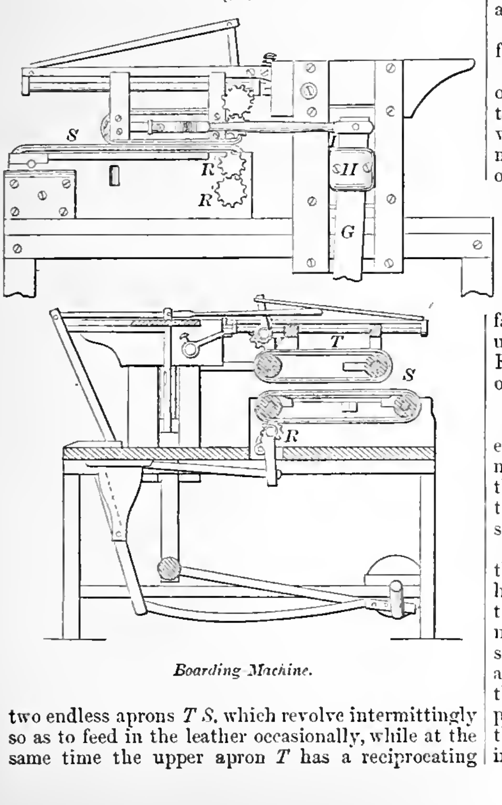
Board'ing. (*Leather.*) The process of rubbing leather with a board to *raise* the *grain* after it has been shaved, daubed, and dried.

Board'ing-gage. (*Carpentry.*) A graduated scribing-tool used as a measurer of width and distance in weather-boarding sides of houses.

Board'ing-joists. (*Carpentry.*) Joists in naked flooring to which the boards are fixed.

Board'ing-ma-chine'. In Fig. 740 is shown a machine in which the leather is carried between two endless aprons *T S*, which revolve intermittingly so as to feed in the leather occasionally, while at the same time the upper apron *T* has a reciprocating motion, adjustable in extent, upon the lower roll *S*. The upper and lower roll respectively are moved a certain distance at each rotation of the drive-wheel by the ratchets *V* and *R* respectively. The reciprocation of the upper roll is by means of the lever *G*, adjustable pivot-box *H*, and pitman *I*.

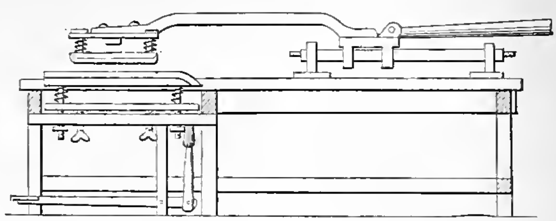
Fig. 740



Boarding Machine.

In Fig. 741 is a simpler form of boarding and graining machine, in which a spring-pad is reciprocated over a spring-bed.

Fig. 741.



Boarding-Machine.

Board'ing-net'ting. (*Nautical.*) Strong nettings of cords, to prevent boarding of a ship in battle.

Board'ing-pike. (*Nautical.*) A pike used on shipboard to repel boarders.

Ship-spears or boarding-pikes are represented in the sea-fight at Medinet Aboo, in Egypt.

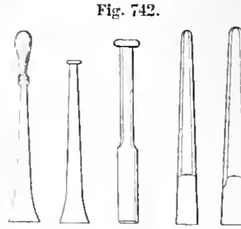
Board-rack. (*Printing.*) Side boards with cleats to hold shelves for standing matter.

Boast'er. (*Masonry.*) A stone-mason's chisel, having an edge two inches wide, used in dressing down the surface of stone. It is intermediate in width between the *inch-tool* and the *broad tool*, which are respectively 1 inch and 3½ inches wide.

Boast'ing. 1. (*Masonry.*) Dressing off the surface of stone with a broad chisel and mallet.

2. (*Sculpture and Carving.*) The roughing out of an ornament, giving the general contour previous to the commencement of the raffles and other details.

Fig. 742.



Boasting-Chisels.

Boast'ing-chis'el. A steel chisel with fine broad edge, used by marble-workers for dressing stone to a nearly smooth surface preliminary to the use of the *broad-tool*. Forms adapted to various kinds of work are shown in Fig. 742.

Boat. A small water-craft.

Boats were one of the earliest devices of nature to enable some of the denizens of the ancient deep to maintain themselves with ease upon the surface of the waters, which their physical structure rendered them ill qualified to do without an extraneous support.

Such were the numerous cephalopod mollusks, as the ammonites, the orthoceratites, and other varieties having chambered shells, which flourished in the waters of the ancient world, and at a later epoch the nautili, species of which still inhabit our warmer seas. Nor are contrivances of this kind confined alone to existences designed to permanently inhabit the waters: a similar provision is made for the temporary support of some insects whose larvæ attain their development in water, as the gnat tribe, including that peculiarly social and familiar insect, the mosquito, whose tender regard for the human race is so touchingly manifested and loudly proclaimed. "A beast familiar to man and signifying—love."

The boat formed by the female gnat consists of from 250 to 350 eggs, and though each is heavy enough of itself to sink in water, the whole structure is perfectly buoyant. Though hollow, it never fills with water, as the surface has a certain repellent action. This little craft has been likened to a river wherry, being sharp, high fore and aft, convex below, concave above, and always floating keel down.

The canoe was probably the first form of boat which succeeded the simple raft, which had supplanted the humble log upon which man first entrusted himself upon the waters. It was much easier to partially burn out a large log, and then finish the work with a pointed stone, than to construct in any other way, with similar tools, a vessel combining equal convenience and speed, and accordingly we find the canoe thus constructed among most primitive nations.

The canoe was the ordinary form of boat in the New World when discovered by Columbus. During his fourth voyage he landed on one of the Guanaja Islands, and was visited by a large trading-canoe remarkable for its size and freight. It was eight feet wide, but formed of a single tree. An awning inclosed a cabin occupied by the wives and children of the cacique, and it was propelled by twenty-five rowers. It was supposed to have come from Yucatan, forty miles distant. The voyagers were clothed with cotton mantles; their bread was made of Indian corn, and they had a beer on board made of the same grain. They had also copper bells, plates, and hatchets as freight.

The endurance and sea-going qualities of some boats of this description are almost incredible; those of the South Sea Islanders and of the inhabitants of the northwest coast of America often make voyages of hundreds of miles, the latter in an inclement and tempestuous ocean; instances are known of the South Sea Island canoes, accidentally blown off from their own island, keeping afloat for months and drifting hundreds of leagues.

A farther advance consisted in the employment of some pliable substance, as hides or birch-bark, sewn together, where the proper materials could be procured.

Ulysses, the hero, made his own boat.

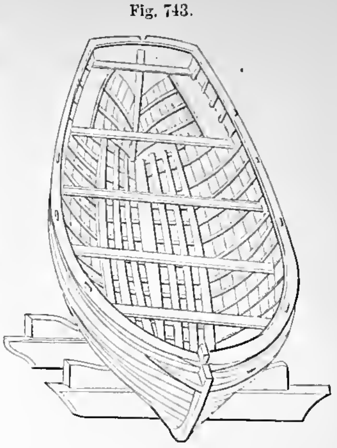
"The boats which come down the river [Euphrates] to Babylon are circular, and made of skins. The frames, which are of willow, are cut in the country of the Armenians, above Assyria, and on these, which serve for hulls, a covering of skins is stretched outside, and thus the boats are made without either stem or stern, quite round like a shield." — HERODOTUS, I. 193.

The modern boats of the Euphrates are of closely woven willow payed with bitumen.

For capability of living in a heavy sea or landing in a heavy surf, no boat constructed can compare with the catamaran (which see), a simple raft formed of three or more logs of light wood, connected together by wooden cross-ties, and having a slightly elevated platform for its occupants to sit on; these are in common use on the coasts of Hindostan and South America, especially for landing goods and passengers through a heavy surf, which they do in safety, when a common ship's boat would be almost instantly dashed to pieces.

Boats built of boards or planks being, in civilized countries, of easier and cheaper construction than any others, and combining great strength with lightness and facility of repair, are generally employed for most purposes, though of late years boats made of corrugated sheet-metal have come into use to a considerable extent. These combine durability, safety, strength, and lightness in the highest possible degree, and for life-boats or for use in harbors, where establishments at which they can be repaired are easily accessible, they seem to unite every desirable requisite; but the impossibility of their repair by an ordinary carpenter, or with the means usually at hand on board ship or in most foreign ports, renders them objectionable in that respect, though when properly made they are little liable to accident. See LIFE-BOAT.

Fig. 743.



Boat.

Paper boats are made by fitting sheets the length of the boat over a model of the exact form; successive sheets, breaking joint, are laid on with a coat of varnish between each. Model and paper envelope are removed to a drying-room, and then payed with boiled oil and turpentine, and then with shellac varnish. The shell is then fitted with an inner frame, thwarts, and the usual appendages.

Ship's boats are named according to their sizes or the nature of their duty. They are known as—

Launch, Long-boat, Barge, Pinnace, Yawl,	Carvel-built.
Galley, Gig, Cutter, Jolly-boat, Dingy,	Clinker-built.

Boats are also known by their purpose or duty; as,—

Advice-boat,	Snag-boat,
Canal-boat,	Stone-boat,
Dispatch-boat,	Submarine-boat,
Ferry-boat,	Surf-boat,
Ice-boat,	Tender-boat,
Life-boat,	Torpedo-boat,
Packet-boat,	Tug-boat,
Passage-boat,	Whale-boat, etc.
Pilot-boat,	

Also by specific names of various imports; as,—

Bateau,	Keel,
Coracle,	Metallic-boat,
Buggy-boat,	Punt,
Bunder-boat,	Scow,
Caique,	Sectional-boat,
Dory,	Skiff,
Flat-boat,	Steam-boat,
Folding-boat,	Wherry, etc.,
Gondola,	

most of which are described under their respective heads.

Boat-bridge. A boat-bridge consists of a track laid on a number of boats anchored parallel in the stream, or moored to ropes or chains which pass from bank to bank.

The bridge thrown across the Hellespont by Xerxes when he invaded Greece, 480 B. C., had a length of 500 paces, and was supported on ships used as *pontons.* Suspension cables of flax and biblos united the ships, transverse beams were laid on the cables; the beams supported plank and earth, and the army marched across, bag and baggage.

Many years after, there appears to have been a more permanent construction of this nature in the same vicinity.

"At Abydos is the Zeugma [or Junction], a bridge of boats which could be unfixed at pleasure for the passage of vessels." — STRABO.

Cyrus, according to Xenophon, crossed the Meander on a bridge supported by seven boats.

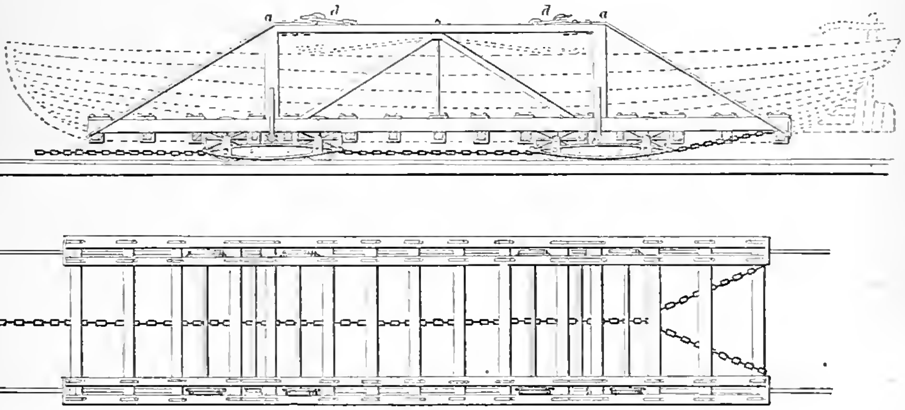
Bridges of boats were in general use in the Middle Ages, and are still used on the Continent of Europe. One at Strasbourg is 1,300 feet long, and there is another at Cologne. One across the Seine at Rouen was constructed by Nicolas in 1700.

Boat-bridges, in a military point of view, are classed as ponton-bridges, the pontons or bateaux and the road-bed being transported on wagons with the army, and thrown across streams as necessity may occur. The bateaux are moored to ropes secured to trees or other safe objects on the respective sides of the river. See PONTON-BRIDGE.

Boat-car. A car adapted for transporting boats up and down inclined planes.

The Morris and Essex Canal in the State of New Jersey leads from Jersey City, on the Hudson, to Easton, on the Delaware, and connects these two rivers. The breadth at the water-line is 32, and at the bottom 16 feet, and the depth is 4 feet. It is 101 miles in length, and is said to have cost $3,000,000. It is peculiar as being the only canal in America in which the boats are moved from different levels by means of inclined planes instead of locks. The whole rise and fall on the Morris Canal is 1,557 feet, of which 223 feet are overcome by locks, and the remaining 1,334 feet by means of 23 inclined planes, having an average lift of 58 feet each. The boats which navigate this canal are 8½ feet in breadth of beam, from 60 to 80 feet in length, and from 25 to 30 tons burden. The greatest weight ever drawn up the planes is about 50 tons. The boat-car used on this canal is shown in elevation and plan, the boat being shown in dotted lines. It consists of a strongly made wooden crib or cradle *a*, on which the boat rests, supported on two iron wagons running on four wheels, upon plate-rails laid on the inclined planes, and raised and lowered by means of machinery driven by water-wheels. The railway on which the car runs extends along the bottom of the canal for a short distance from the lower extremity of the plane; when a boat is to be raised, the car is lowered into the water, and the boat, being floated over it, is made fast to the part of the framework which projects above the gunwale, as shown in the drawing at *d*. The machinery is then put in motion, and the car, bearing the boat, is drawn by a chain to the top of the inclined plane, at which there is a lock for its reception. The lock is furnished with gates at both extremities; after the car has entered it, the gates next the top of the inclined plane are closed, and, those next the canal being opened, the water flows in and floats the boat off the car, when she proceeds on her way. Her place is supplied by a boat traveling in the opposite direction, which enters the lock, and, the gates next the canal being closed and the water run off, she grounds on the car. The gates next the plane are then opened, the car is gently lowered to the bottom, when it enters the water, and the boat is again floated.

Fig. 744

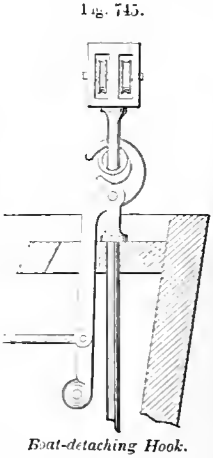


Boat-Car.

Boat-de-tach'ing Hook. (*Nautical.*) One adapted to be suddenly cast loose when a boat lowered from the davits touches the water. It is important that the hooks which engage the eye-bolts, stem and stern, should be instantly and simultaneously disengaged when the boat touches water. This is done by upsetting the hooks, the opening of sister-hooks, or the tripping of a trigger.

In Fig. 745 the boat is attached to the davit-blocks by the hooks of pivoted levers connected together so as to ensure simultaneous release. The pivot-supports of the hook-levers have projections preventing release before the hooks are turned up.

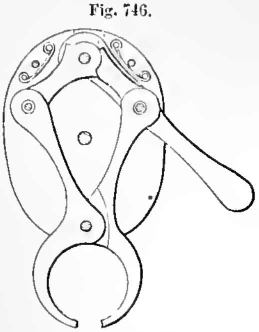
Fig. 745.



Boat-detaching Hook.

In Fig. 746 the incurved lower ends of the levers form jaws, which are operated by a toggle at the

Fig. 746.

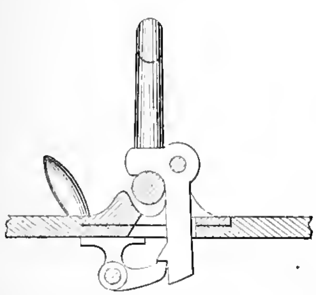


Davit-Block Hook.

upper ends of the levers. Each half of the hook forms a mousing for the other.

In Fig. 747 the hook or link at the end of each davit-fall passes under one branch of a pivoted arm, the other branch of which has a projection held by a pivoted catch, turning on a shaft running lengthwise of the boat. By turning a handle attached to this shaft, the two catches retaining the arms simultaneously release them, allowing them to slip off the hooks or links of the davit-falls.

Fig. 747.



Boat-Detaching Hook.

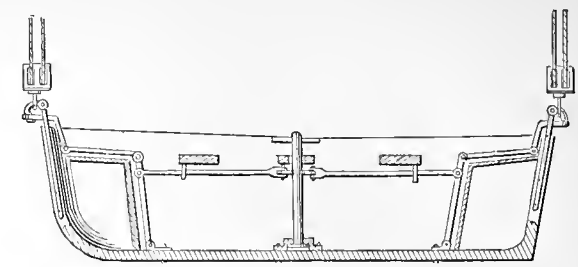
Boat–hook. A pole whose end is furnished with an iron having a point and a hook. It is used for holding on to a boat or other object, and is a part of the boat's appurtenances.

Also known as a *gaff; setter; setting-pole; pole-hook; hitcher.*

The *contus nauticrium* of the ancients.

Boat Low'er-ing and De-tach'ing Ap-pa-ra'tus. The ordinary boat lowering and hoisting apparatus consists merely of two falls passing through double blocks and suspended from the davits. The lower blocks hook into rings at each end of the boat, and are unhooked by hand after the boat is lowered. In lowering a boat in a heavy sea, this arrangement is troublesome and inconvenient, as a failure to detach both hooks simultaneously may lead to the swamping of the boat. To remedy this, and to enable both ends of the boat to be cast off at one operation, a number of contrivances have been devised. These devices generally take the form of means for casting loose the hooks fore and aft with absolute certainty and simultaneously. Sometimes it is a rod which is withdrawn so as to let the hooks fly loose. Of this character is the device shown in Fig. 748, in which the eyes of the davit-fall blocks are engaged by pivoted hooks at the stem and stern respectively of the boat. The hooks are detained by

Fig. 748.



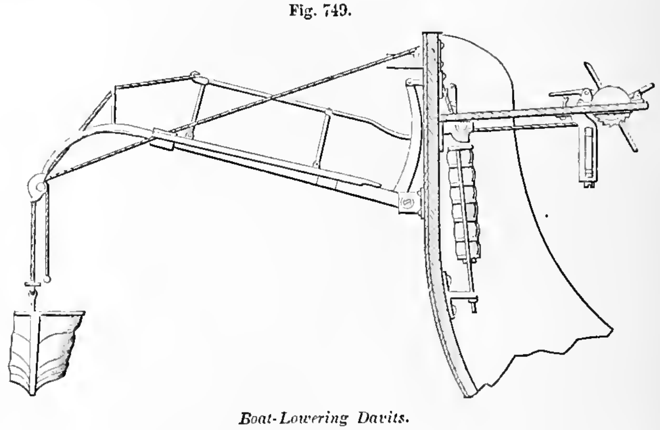
Boat-Detaching Tackle.

links, which are simultaneously withdrawn by lever connection with a rotating shaft amidships.

There are various modifications of this form of the device.

In Fig. 749 the davits are hinged in such manner as to swing freely in vertical planes toward and from the water, and to vibrate above and below a horizontal plane intersecting their axis of motion.

Fig. 749.



Boat-Lowering Davits.

Curved sections are applied to the upper ends of the davits, which are hinged at their lower ends, so that said sections can be turned around independently of the standards to which they are attached.

The davits are counterpoised by a force sufficient to raise them without the boat, but easily overcome by the weight of the boat.

Bob. 1. (*Metal-working.*) A small buff-wheel used in polishing the insides of spoons. It is a disk of leather nearly an inch thick, known as *sea-cow* or *bull-neck*. It is perforated, mounted on a spindle, and turned into a nearly spherical form.

2. (*Horology.*) The weight of a pendulum.

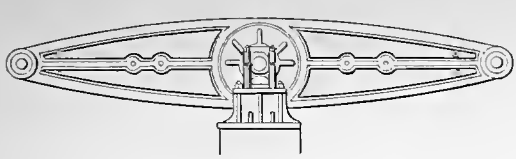
3. The suspended ball of a *plumb-line*.

4. The shifting weight on the graduated arm of a *steelyard*.

5. (*Mining.*) A rocking-post framed into a pivoted bar and driven by the crank of the water-wheel or engine-shaft. To one end of the beam is suspended the pump-rod, and the other is counter-weighted to balance the said rod.

6. (*Steam-Engine.*) A working-beam.

Fig. 750.



Engine-Bob.

Bob'bin. (*Sewing-Machine.*) A small spool adapted to receive thread and to be applied within a shuttle.

(*Spinning.*) A spool with a head at one or both ends to hold yarn. It has one head when it serves as a cop in spinning, as a thread-holder in shuttles of looms, and as cop in warping-machines. In spinning or warping it is slipped on a spindle and revolves therewith, being held thereon by a spring or by the tightness of its fit.

It has two heads when used as a spool for sewing-thread, as a bobbin for sewing-machine shuttles, and sometimes as a warp-holder in looms where each warp is independent.

The Wheeler and Wilson sewing-machine has a circular bobbin of lenticular shape, which holds the lower thread, and is dropped through the loop of the upper thread, distended for that purpose by the rotating hook.

Braiding-machine bobbins have two heads, the upper one notched as a ratchet, to receive the stopping-arm attached to the let-off mechanism. GREENHALGH's Patent, April 13, 1869. The bobbin rotates freely on its shaft; its thread passes through an eye in a standard and one in a tension-weight sliding thereon. The stopping-arm is attached to a sleeve on the standard, and is supported in the ratchet-openings of the bobbin-head until the tension-weight is raised by the thread to trip it and release the bobbin, which then rotates freely and pays off the thread until the slack allows the tension-weight to fall and release the stopping-arm, which again engages with the head of the bobbin.

Bobbins are variously constructed, and of divers materials.

Materials, — clay, wood, ivory, hard rubber, porcelain, glass, papier-maché, corrugated metal, malleable cast-iron.

Having metallic barrels and disks of the same for heads; of wood turned; of cylinders with one head each, and slipping one into the other telescopically; with paper bodies; polygonal prisms with buttons on the ends; having a number of different-sized circumferential grooves.

Bob'bin and Fly Frame. The ordinary *roving-machine* of the cotton manufacture. Its duty is to draw and twist the *sliver*, and wind the roving on a bobbin.

The *bobbins* containing the *slivers* are mounted in several rows on a *creel* which has *skewers* for their reception. Each sliver passes between a pair of guides, which give it a horizontal traversing motion, so that it shall not bear upon a constant part of the surfaces of the drawing-rollers between which it next passes. These drawing-rollers are arranged in pairs (see DRAWING-FRAME), and have a relatively increasing rate of speed, the second revolving faster than the first and the third faster than the second. This proportion may be, say, first rollers 1 inch in diameter and 60 turns per minute; delivering rollers, $1\frac{1}{4}$ inches in diameter and 180 turns per minute. By this proportion the first roller would deliver 188.4 inches per minute, while the *front* or delivery pair passes 705.5 inches per minute, the roving becoming elongated $3\frac{3}{4}$ turns by the operation.

After leaving the rollers the sliver is received by the spindles, which are arranged in two rows for economy of room. The vertical spindles are driven by bevel-wheels from bevel-pinions, or horizontal shafts extending the whole length of the machine. Supported upon each spindle is a *flyer*, which has a hollow axis and a hollow arm, through both of which the roving passes in order to reach the bobbin, which is placed upon the spindle, and revolves loosely thereon by its own positive motion, derived from bevel-gearing, shown beneath it in the figure. The lower bevel-gearing is for the rotation of the *spindle* and *flyer*, and gives the twist. The upper bevel-gearing is for the rotation of the *bobbin*, and winds the *roving* thereon. The flyer has one tubular arm to lead the roving, and one solid arm which acts as a counterbalance to the former to prevent agitation during the rotation at high speed, say 1,300 revolutions per minute.

The bobbin has two motions, — one around the spindle on which it is sleeved, and one up and down on the spindle. The former is for the winding on of the roving, and the latter to distribute the roving in coils alongside each other along the length of the bobbin.

There are three inequalities to the motion of the bobbin, — one in the rate of its revolution, another in the length of its vertical traverse, and a third in the rate of its traverse. The inequality of rotation is for the purpose of winding equal roving in equal time, notwithstanding the increasing diameter of the *cop*. The rate of winding on is of necessity equal to the rate of delivery from the *front* pair of drawing-rollers, and it follows that the rate of winding must be uniform. As layer after layer of coils accumulates upon the bobbin, the latter receives a decrease of speed exactly equivalent to its increase of diameter. This is accomplished by *cone*-pulleys by which the driving-band is shifted to a part of the *driven*-pulley having a larger diameter, the band having a constant rate. See CONE-PULLEYS.

The vertical motion of the bobbins is by means of raising and lowering the *copping-rail* on which the whole row or the two rows of bobbins rest, sliding the bobbins up and down on the spindles. The inequality of *length* of vertical motion is for the purpose of giving a gradually decreasing length to each successive layer of coils, giving a conical end to the completed cop, so that each layer contains an equal length of roving, its diminution in length counterbalancing its increase in diameter. The inequality of *rate* of vertical motion is to enable the yarns to lie compactly side by side in the coils, notwithstanding the changes in the rate of revolution due to changes in the diameter of the *cop*.

While the *twist* depends upon the rotation of the *spindle* and *flyer*, the degree of twist depends upon the ratio between the delivery at the front pair of *drawing-rollers* and the revolutions of the spindle. "The winding on of the twisted roving upon the bobbin is effected by giving to the bobbin such a velocity that the difference between the motion of the surface of the bobbin and the motion of the delivering end at the arm of the flyer, shall equal the surface-motion of the roller or the supply of the sliver. The spindle and bobbin being driven by different movements and at different rates, the winding is effected either by making the bobbin revolve a little faster than the spindle, or the spindle faster than the bobbin. If, for example, the bobbin revolves 50 times while the spindle only revolves 40, 40 turns of the bobbin will have nothing to do with the winding; but there are 10 turns of the bobbin above those of the flyer, which will perform the winding. Hence the 40 turns of the spindle produce twist, while the 50 turns of the bobbin produce 10 coils of the roving upon its barrel."— TOMLINSON.

Bobbin and fly frames are of two kinds, *coarse* and *fine*, or *first* and *second*.

The *coarse*, or *first*, *bobbin and fly frame* acts upon *slivers* from cans filled at the *drawing-frame* and placed at the back of the machine.

The *fine*, or *second*, *bobbin and fly frame* acts upon *rovings*, or *slubbings* as they are often called, from *bobbins* filled at the first frame and placed on the *skewers* of the *creel* placed behind the *roller-beam*.

The object of the repetition is to obtain a greater degree of *drawing* and *twist* than could be safely imparted at the first operation, when the *sliver* or *card end* had but little coherence.

In the coarse bobbin and fly frame it is usual to make the spindle revolve quicker than the bobbin, and in the fine frame to make it go slower. The relation of the speed and proportions are well explained by Dr. Ure with an elaborateness impossible within our limits.

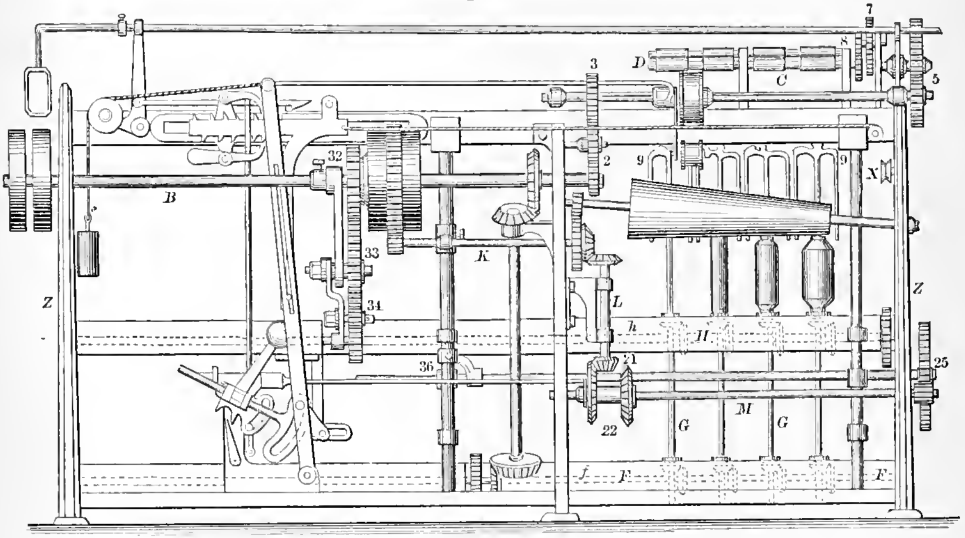
In the coarse roving-frames the spindles make on an average 750 revolutions per minute, turning off for each spindle 400 inches per minute or 666⅔ yards per hour. In the fine frame there is more twisting power, and this produces about 533 yards per hour. In the coarse frame the *sliver* is elongated from four to six times, one quarter of the draft being between the first and second pairs of rollers, and the remaining three quarters between the second and the delivery pairs of rollers.

As the drawing-rollers and the spindles are driven by positive though determinate motions from the same shaft, the number of twists to an inch of the sliver delivered from the front pair of drawing-rollers is uniform after the work is started, irrespective of the rate of winding on the bobbin or the actual speed of the machine. The relation is adjustable before starting by changeable gearing intervening between the main shaft and the spur-wheels of the drawing-rollers. If the drawing-rollers pay out 706 inches of sliver and the flyers make 1,300 revolutions, the amount of twist will be nearly 1¾ to an inch. This is but slight, but is usual in the *first roving-machine*, a draw and twist being afterwards given in the *second roving-machine*; the processes being repeated either in the *throstle* or the *mule*, in one of which the yarn is finished.

For the adjustment of different degrees of twist in different yarns a differential gearing is used. See EQUATIONAL BOX.

B, main shaft, driven by a band from the engine.

Fig. 751.



Bobbin and Fly Frame.

2, 3, 5, 7, 8, *C*, *D*, train for driving drawing-rollers.

F F, long horizontal shaft below the beam *f*, driven by gearing from the main shaft, and driving the spindles *G*.

h, copping-beam on which the bobbins rest, and which is fitted with slides to the end frames *Z*.

9, flyer pressed on to the top of the spindle.

X, pulley for the chain of the weight which counterbalances the weight of the copping-rail.

H, horizontal shaft carrying the bevel gears by which are rotated the disks in the copping-rail *h*, on which the bobbins are fixed to rotate as they traverse up and down on the spindles *G*.

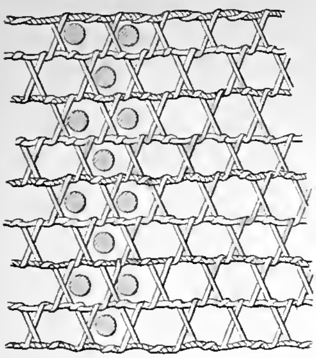
C, *K*, *L*, 21, *M*, 22, 25, shafting and train driving the pinion and rack 36, by which the copping-rail is vertically actuated; right and left bevel-wheels 22 (and another not shown), sliding on shaft *M*, to engage alternately with pinion 21, to give the motions of the copping-rail.

32, 33, 34, train connected with the *cone-pulley* for variable speed, and driving-shaft *H*, which revolves the bobbins by the intervention of bevel-gears. The wheels are connected by elbow-links, so as to mesh, irrespective of the vertical position of the copping-rail *h* and its adjuncts.

Bob-bin-et′. (*Fabric.*) A machine-made cotton net, originally imitated from the lace made by bobbins upon a pillow.

It consists of a series of parallel threads which may be considered as *warp*-threads, and two systems of oblique threads which proceed from the right to

Fig. 752.



Bobbinet.

the left, and from the left to the right respectively. Each weft thread has a single turn around each crossing of a warp, and the contrary strain of the respective weft threads gives a serpentine course to the warps.

The thread that makes the bobbinet is supplied partly from bobbins and partly from a warp. The bobbins are small brass pirns, and swing with a pendulous motion between the warp-threads so as to wrap the weft round the warp.

The bobbinet-machine was originally derived from the stocking-frame, invented by the unfortunate William Lee, M. A., of Cambridge, 1589.

Lee was successively patronized by Elizabeth and by Henry IV. of France. The former liked the stockings well enough, but refused Lee a patent, as the invention was so valuable that it would command the market. The assassination of Henry deprived Lee of a more generous patron, and he fell into poverty, obscurity, and an untimely grave.

Hammond (about 1768) modified a stocking-frame to make a coarse imitation of Brussels ground; this was the *pin*-machine.

In 1784, the *warp-frame* was invented, for making *warp-lace*.

In the next decade, the *bobbin-frame*.

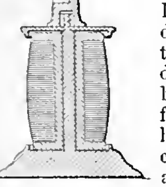
In 1809, Heathcote invented the *bobbinet* machine.

This is a complicated machine, used in but few localities. The parts are very numerous, the motions intricate, and the machine cannot be readily explained within the limits admissible in this work.

Bob'bin-lace. (*Fabric.*) Lace made upon a pillow with bobbins. The pillow is a hard cushion covered with parchment on which the pattern of the meshes is drawn. Pins are inserted into the lines of the pattern and determine the meshes. Thicker thread, called gimp, is interlaced with the meshes, according to the pattern on the parchment. The thread is wound upon bobbins, and is twisted, crossed, and secured by pins. See PILLOW-LACE.

Bob'bin-stand. A frame for holding the bobbins for warps of a loom, threads of a warping-machine, and yarns of a spinning-machine.

Fig. 753.

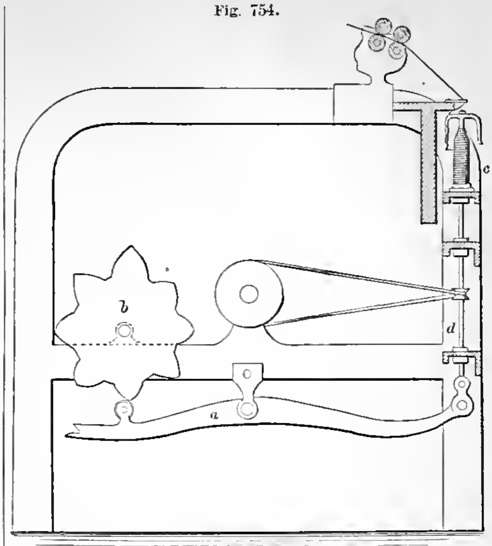


Bobbin-Stand.

The bobbin or reel rotates on a spindle fixed in a base-plate. It is covered with a metallic disk, supported a little above the top of the spool on a shoulder of the spindle, and held down by a screw-nut. An improved form provides flanges or annular lips projecting from the base and cap to inclose the spool-heads, and prevent the twine from catching under the heads. It is surmounted with a twine-cutter.

Bob'bin-wind'er. 1. (*Weaving.*) The thread or yarn is directed to the eye of the guide, which is at the end of a shaft automatically raised and lowered, to lay the thread spirally and conically on the

Fig. 754.

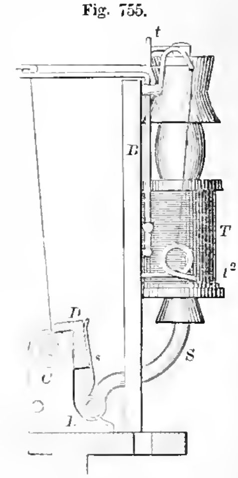


Bobbin-Winder (for Looms)

bobbin by a lever *a* bearing against a cam *b*, so shaped that as the layers of thread are built up, the length of throw increases; the bobbin *c* is supported on a fixed shaft *d* rotated continuously.

2. (*Sewing-Machine.*) A device adapted to receive a shuttle-bobbin and rotate it so that it may be wound with thread. The winders are usually operated by being turned in contact with the driving-wheel, balance-wheel, or band. Some winders are supplied with an automatic thread-distributor, to lay the thread evenly.

Fig. 755.



Bobbin-Winder (for Shuttle-Bobbins of Sewing-Machines).

Winders for the shuttle-bobbins of sewing-machines have arrangements for laying the thread regularly. A traverse guide is automatically reciprocated to lay the thread evenly and compactly, or the bobbin is reciprocated to receive it. When filled, the winding ceases by a stop-motion or through an alarm.

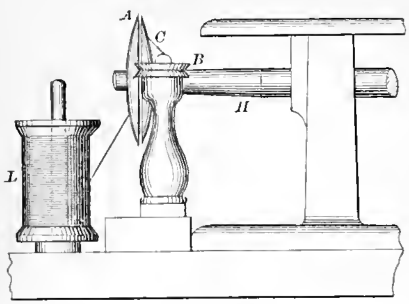
In the illustration, the arbor on which the bobbin is placed is rotated by the temporary contact of a friction-wheel against the fly-wheel of the machine.

The vibrating presser *D* is T-shaped, and is pivoted by its lower end to a horizontal bar *E*, and acted on by a spring *s*. The upper portion or T-head of this presser is somewhat longer than the bobbin *C*, but that portion which impinges against the thread on the bobbin is of such width as to be received between the heads of the bobbin. *S* represents the vertical rod on which the spool *T* is applied. *B* represents a rod which is provided with fixed thread-guides t^1 t^2 and a horizontal vibrating thread-guide *t*.

The winder for lenticular spools of sewing-machines has a spindle on which the bobbin is held while being rotated by the power of the sewing-machine.

The thread from the spool *L*, instead of being held by the fingers as the bobbin revolves, is passed around the tension *B*, and thence to the bobbin *A*. On operating the sewing-machine the thread will be wound up on the bobbin *A*, by the rotation of the

Fig. 756.

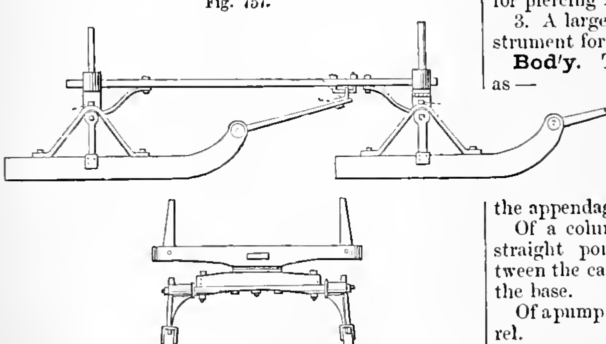


Bobbin-Winder.

shaft *H*, compactly and uniformly by the action of the tension *B*. This will continue until the bobbin *A* is filled, when the thread will override and slip over the edge of the bobbin, down upon the knife *C*, and be instantly cut off.

Bob-sled. A compound sled composed of two

Fig. 757.

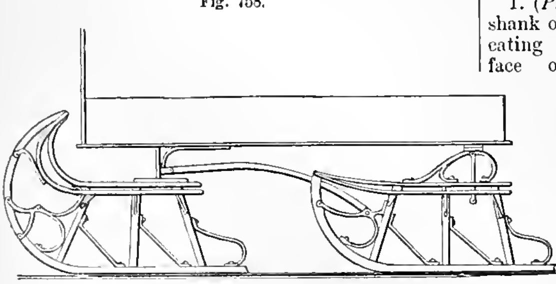


Bob-Sleds.

short sleds, one in front and another behind, connected together longitudinally by a reach.

Bob-sleigh. A sleigh made up of two short (bob) sleighs connected by a reach or coupling. In the illustration, the reach is curved upward to allow the fore bob to pass beneath the reach in turning.

Fig. 758.



Bob-Sleigh.

The body is supported on pendent bars and hanging links.

Bob'stay. (*Nautical.*) One of the chains or ropes which tie the bowsprit end to the stem, to enable it to stand the upward strain of the fore-stays.

Bob'stay-piece. (*Shipbuilding.*) A piece of timber stepped into the main piece of the head, and to which the bobstay is secured. See STEM.

Bo'cal. (*Glass.*) A glass jar with a short, wide neck.

Boc'a-sine. (*Fabric.*) A kind of calamanco or woolen stuff.

Boc'ca. (*Glass.*) The round hole in a glass-furnace from which the glass is taken out on the end of the pontil.

Boc'ca-rel'la. (*Glass.*) A *small bocca* or mouth of a glass-furnace. A *nose-hole.*

Boc'ci-us-light. A form of gas-burner invented by Boccius, and consisting of two concentric metallic cylinders placed over the flame and within the usual lamp glass, so as to modify the combustion and increase the brilliancy of the light.

Bock'ing. (*Fabric.*) A coarse woolen fabric, originally made at Bocking, England.

Bod'kin. Anciently, a dagger. (Welsh, *bidogyn*, a dagger; diminutive of *bidog*, a sword.)

"Might his quietus make with a bare bodkin."

1. (*Printing.*) A printer's awl, for picking letters out of a column or page in correcting.

2. (*Bookbinding.*) A pointed steel instrument for piercing holes, used by bookbinders and others.

3. A large-eyed and blunt-pointed threading instrument for leading a tape or cord through a hem.

Bod'y. The principal portion of an object; such as —

Body of a carriage or wagon; the part to contain the load.

Of a type; the shank.

Of a boiler, barrel, or bell; the main portion as distinguished from the appendages.

Of a column; the straight portion between the capital and the base.

Of a pump; the barrel.

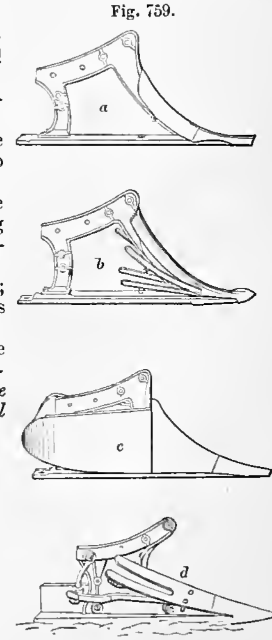
Of a spoke; the part between the hub and felly tenons.

Of a still; the chamber containing the wash; the *cucurbit*.

Of an implement; the part stocked, as of a plow.

1. (*Printing.*) The shank of a type, indicating size, as *agate* face on *nonparcil*

Fig. 759.



Plow-Body.

body ; larger than the usual body of *agate*, and therefore having the effect of spacing or putting the letters more widely apart.

2. (*Music.*) The upper and resonant portion of an organ-pipe above the *reed* or the *mouth*, by which vibration is imparted to the air.

3. (*Vehicle.*) The bed, box, or receptacle for the load.

4. (*Agricultural Implements.*) The portion of an implement engaged in the active work ; as, "various *bodies* of plows may be attached to a plow-stock, according to the work in hand."

a, subsoil body. *c*, ridging body.
b, potato body. *d*, digging body.

Bod'y-hoop. (*Nautical.*) The bands of a built mast.

Bod'y-loop. (*Vehicles.*) An iron bracket or strap by which the body is supported upon the spring bar.

Bod'y of a Place. (*Fortification.*) *a.* The works next to and surrounding a town, in the form of a polygon, regular or irregular. — GRIFFITHS.

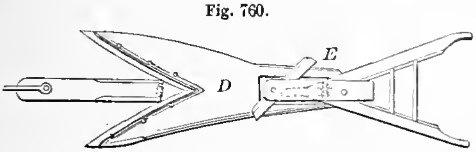
b. The space inclosed within the interior works of a fortification.

Bod'y-plan. (*Shipbuilding.*) An end elevation, showing the *water*-lines, *buttock and bow* lines, *diagonal* lines, etc.

Bod'y-post. (*Shipbuilding.*) The post at the forward end of the opening in the dead-wood in which the screw rotates.

Bog-cut'ting Plow. An implement for cutting and turning up boggy or peaty soil for fuel or chemical uses. In the example, the pronged sole-plate *D* has

Fig. 760.



Bog-Cutting Plow.

cutters attached beneath, and is followed by a moldboard *E* attached to the standard. A colter may be placed on the left prong of the sole-plate.

Bo'gie. (*Steam-Engine.*) A four-wheeled truck supporting the fore-part of a locomotive, and turning beneath it to some extent, if necessary.

Bo'gie-en'gine. (*Steam-Engine.*) A locomotive-engine employed at a railroad station in moving cars and making up trains. The driving-wheels and cylinders are on a truck which is free to turn on a center-pin.

Bo'gie-frame. (*Railroad Engineering.*) A four-wheeled truck, turning on a pivoted center, for supporting the front part of a locomotive-engine.

Bo-he'mi-an Glass. (*Glass.*) A clear crown glass, a silicate of potash and lime, a little of the silicate of alumina being substituted for the oxide of lead. The silica for this glass is obtained by pounding white quartz.

Boil'er. A vessel in which liquid is boiled.

1. Household-boilers are *kettles, saucepans,* and *clothes-boilers.*

2. The boiler for raising steam may be fairly called a *steam-generator.* See STEAM-BOILER.

3. The dyer's boiler is called a *copper.*

4. That of the sugar-worker is a *pan.*

5. That of the distiller, a *still.*

6. The chemist's boiler may be a *retort, alembic,* etc.

7. Lard and tallow rendering is performed in a *digester,* or *tank.*

The list below includes many of the different kinds of boilers — not the varieties of the kinds — and their parts. Most of them are described under their respective heads.

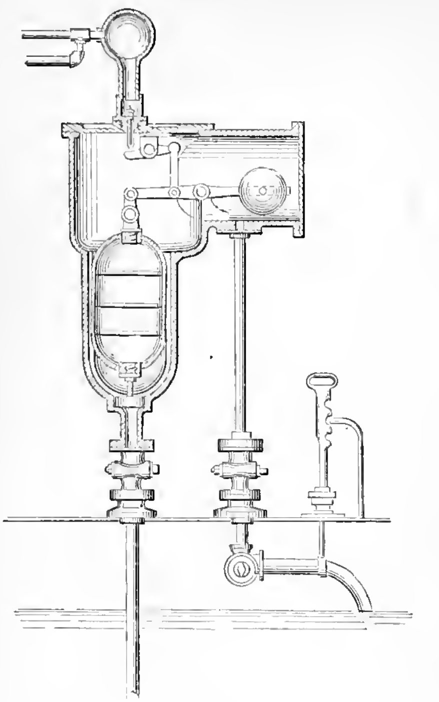
Agricultural boiler.
Air-heating boiler.
Bath-heater.
Blow-off pipe.
Boiler-alarm.
Boiler-feeder.
Boiler-float.
Boiler-prover.
Boiler-tube.
Brine-pump.
Brine-valve.
Caravan-boiler.
Cast-iron-boiler.
Coffee-boiler.
Cold-water boiler.
Cold-water pump.
Cornish boiler.
Culinary boiler.
Cylinder-boiler.
Detector, Low-water
Domestic boiler.
Egg-boiler.
Feeder, Boiler.
Feed-head.
Feed-pipe.
Feed-pump.
Feed-water apparatus.
Float.
Flue.
Flue-brush.
Flue-cleaner.
Flue-surface.
Foam-collector.
Fusible plug.
Gage-cock.
Gage-glass.
Generator, Steam
Giffard injector.
Heating surface.
High-pressure alarm.
Hot-water heating-apparatus.
Hot-water pump.
Hot-well.
Incrustation in boilers, Removing
Instantaneous generator.
Jacket.
Lagging.
Lard-boiler.
Lard-renderer.
Lock-up safety-valve.
Low-water alarm.
Low-water detector.
Low-water indicator.
Man-hole.
Mud-collector.
Mud-plug.
Mud-valve.
Multiflue-boiler.
Multitubular boiler.
Portable boiler and furnace.
Pressure-gage.
Priming-valve.
Safety-plug.
Safety-tube.
Safety-valve.
Salinometer.
Scale-borer.
Sectional steam-boiler.
Sediment-collector.
Skimmer.
Soap-boiler.
Steam-boiler.
Steam-boiler alarm.
Steam-cock.
Steam-coil.
Steamer.
Steam-gage.
Steam-generator.
Steam-heating apparatus.
Steam-jacket.
Steam-pressure gage.
Teakettle.
Tube.
Tube-brush.
Tube-cleaner.
Tube-cutter.
Tube-door.
Tube-expander.
Tube-fastener.
Tube-ferrule.
Tube-flue.
Tube-plate.
Tube-plate stay.
Tube-plug.
Tube-scaler.
Tube-sheet.
Tube-stopper.
Tubular boiler.
Wagon-boiler.
Wash-boiler.
Water-back.
Water-bridge.
Water-gage.
Water-heater.
Water-indicator.
Water-injector.
Water-leg.

Boil'er-a-larm'. An apparatus or device for indicating a low stage of water in steam-boilers. See STEAM-BOILER ALARM ; LOW-WATER ALARM.

Boil'er-feed'er. An arrangement, usually automatic and self-regulating, for supplying a boiler with water. The simple force-pump or injector, as worked by the engine or boiler, may or may not have self-regulating devices by which a nearly constant water-level is maintained, but there are other devices by which the variation in the water-level is made to bring into or withdraw the operative parts. See FEED-WATER APPARATUS.

One automatic arrangement is shown in Fig. 761. When steam is admitted through the short leg of the siphon into the chamber above, the weight ceases to balance the float, and the latter, sinking, opens the water-supply, which ceases as the water rises in the

Fig. 761.



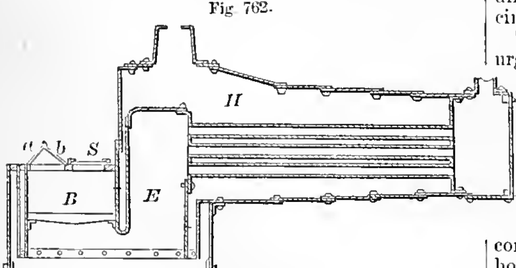
Boiler-Feeder.

boiler above the opening of the said leg of the siphon. The water-level in the boiler at which steam shall be so admitted is regulated by adjusting the said leg.

Boil'er-float. (*Steam-Engine.*) A float which rises and falls with the changing hight of water in a steam-boiler, and so turns off or on the feed-water.

Boil'er-fur'nace. (*Steam-Engine.*) One specifically adapted for the heating of a steam-generator. The shapes vary with those of the boilers themselves,

Fig. 762.



Boiler-Furnace.

the latter being cylindrical, wagon-shaped, vertical, etc. The illustration is an example of a downward draft-furnace, in which *a b* are the fuel-doors, *S* the draft-damper, *B* the furnace, *E* the fire-box, *H* the steam-space.

Boil'er-i'ron. Rolled iron of $\frac{1}{4}$ to $\frac{1}{2}$ inch thickness, used for making steam-boilers, tanks, the skin of ships, etc.

Boil'er-pro-tect'or. A non-conducting covering to prevent the escape of heat. Among the devices for this purpose may be cited, —

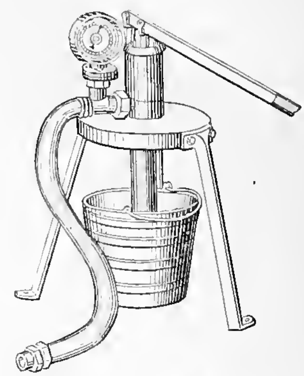
Felt, treated in various ways. *Asbestos.*

Lagging.

Allied to the above in position, if not in duty, are water-jackets to utilize the heat, air-flues and shields to protect surrounding bodies against the radiated heat.

Boil'er-prov'er. (*Hydraulics.*) A force-pump with pressure-indicator, used to try the power of a boiler to resist rupture under a given stress of hydraulic pressure.

Fig. 763.



Boiler-Prover.

Boil'er-stay. (*Steam-Engine.*) A tie-bar by which the flat plates on the opposite sides of boilers are connected, in order to enable them to resist internal pressure. The stays cross an intervening water or steam space.

Boil'er-tube. (*Steam-Engine.*) The tubes by which heat from the furnace is diffused through the mass of water in locomotive and other boilers of the smaller class. They are usually arranged longitudinally of the boiler, and are fitted by steam and water-tight connections to its heads. A *tube* carries water; a *flue* carries flame and the volatile products of combustion.

Boil'er-y. A *salt-house* or place where brine is evaporated.

Boil'ing-fur'nace. (*Metallurgy.*) A reverberatory furnace employed in the decarbonization of cast-iron to reduce it to the condition for mechanical treatment by hammer, squeezer, and rolls, by which it is brought into bar or plate iron. The term *boiling* refers to the bubbling which takes place during the process of conversion, and the word is somewhat local. This modification of the puddling-furnace was invented by Hall, and consists mainly in some differences in the proportion of the parts, the use of cinder, and of a greater heat.

The furnace is heated to an intense heat by a fire urged with a blast. The cast-iron sides are double, and a constant circulation of water is kept passing through the chamber thus made, in order to preserve the structure from fusion by the heat. The inside is lined with fire-brick covered with metallic ore and slag over the bottom and sides, and then, the oven being charged with the pigs of iron, the heat is let on. The pigs melt, and the oven is filled with molten iron. The puddler constantly stirs this mass with a bar let through a hole in the door, until the iron boils up or "ferments," as it is called. This ebullition is caused by the combustion of a portion of the carbon in the iron, and as soon as the excess of this is consumed, the cinders and slag separate from the semifluid mass, which the puddler stirs and forms into balls of such a size as he can conveniently handle, which are taken out and carried on ball-trolleys to the squeezer.

Bois-dur'ci. A compound of sawdust from hard wood, such as rosewood or ebony, mixed with blood and other cementing material, and used to obtain medallions or other objects by pressure in molds.

Bo'las. A form of missile used by the Paraguay Indians, the Patagonians, and the Esquimaux. The *bolas* of the Patagonians has several varieties. That used in war consists of a single ball of hardened clay or rounded stone, weighing about a pound, and fastened to a stout rope of sinew or skin. This they sometimes throw at their adversary, rope and all, but generally they prefer to strike his head with it, like a slung-shot.

For hunting, they use two similar stones, fastened together by a rope, which is generally three or four yards long. One of the stones the hunter takes in his hand, and then, whirling the other round his head, throws both at the object he wishes to entangle. Sometimes several balls are used, but two is the usual number. They do not try to strike the object with the balls, but with the rope, and then, of course, the balls swing round in different directions, and the thongs are wrapped around the object. It is said that the natives can use the *bolas* effectually at eighty yards.

The *bolas* of the Esquimaux consists of a number of walrus teeth attached to the ends of strings whose other ends are united into a knot.

Fig. 764.

Bolection Molding

Bo-lec'tion. (*Joinery.*) Moldings surrounding the panels of a door, gate, etc., and which project beyond the general face of the same.

Bol'lard. (*Nautical.*) *a.* A large post or bitt on a wharf, dock, or on shipboard, for the attachment of a hawser or warp, in towing, docking, or warping.

b. A rundle in the bow of a whale-boat around which the line runs in veering; called also *loggerhead.*

Bol'lard-tim'ber. (*Shipwrighting.*) A timber, one on each side of the bowsprit near the heel, to secure it laterally. A *knighthead.*

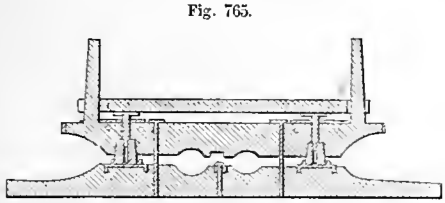
Bo-log'na-vi'al. (*Glass.*) A small unannealed vessel of glass, open at the upper end and rounded at the bottom end, which is thick. It will withstand a moderate blow on the bottom, but is cracked by dropping into it a small, angular piece of flint.

It is an example of the inherent strain and unstable static condition incident to unannealed glass. See ANNEALING.

Bol'ster. 1. (*Vehicle.*) The transverse bar over the axle of a wagon, which supports the bed, and into which are framed the standards which secure the bed laterally.

In the illustration, rubber springs are interposed between the axle and the bolster. Pistons beneath

Fig. 765.

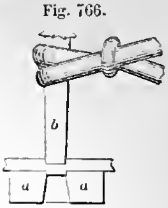


Wagon-Bolster.

the bed pass through the bolster and rest upon the springs, so as to give an elasticity to the bed up and down between the standards.

2. (*Machinery.*) *a.* A bed-tool *a* in a punching-machine. The perforated part on which a plate rests when the punch *b* drives out the *bur* or *planchet.* It has an opening of the same size and shape as the punch itself.

Fig. 766.



Bolster and Punch.

b. A perforated block of wood on which sheet-metal is laid for punching.

3. (*Music.*) The raised ridge which holds the tuning-pins of a piano.

4. (*Nautical.*) *a.* A piece of timber adjoining the hawse-hole, to prevent the chafing of the hawser against the cheeks of a ship's bow.

b. A cushion within the collar of a stay, to keep it from chafing on the mast.

c. A piece of wood or roll of canvas, upon which a rope rests, to keep it from chafing something or to give it a proper bearing.

5. (*Carpentry.*) *a.* A horizontal cap-piece laid upon the top of a post or pillar, to shorten the bearing of the beam of a string-piece above.

b. One of the transverse pieces of an arch centering, running from rib to rib and supporting the *voussoirs.*

6. (*Saddlery.*) A padded ridge on a saddle.

7. (*Ordnance.*) A block of wood fixed on the stock of a siege-gun carriage, on which the breech of the piece rests when it is shifted backward for transportation.

8. (*Railroad Engineering.*) The principal cross-beam of a railroad truck or car body.

9. (*Civil Engineering.*) The resting-place of a truss-bridge on its pier or abutment.

10. (*Cutlery.*) *a.* The shoulder of such instruments and tools as knives, chisels, etc., at the junction of the *tang* with the blade or the shank, as the case may be.

b. A metallic plate on the end of a pocket-knife handle.

11. (*Spinning-Machinery.*) The spindle-bearing in the rail of a spinning-frame. It forms a sleeve-bearing for the vertical spindle some distance above the lower bearing, which is called the *step.*

Bol'ster-plate. (*Vehicles.*) An iron plate on the under side of the bolster, to diminish the wear caused by its friction on the axle.

Bolt. 1. (*Machinery.*) A stout metallic pin, employed for holding objects together; frequently screw-threaded at one end to receive a nut.

Bolts may be divided into two principal classes, namely, those which are intended for fastening objects together permanently; and movable bolts, such as lock, sash, door, and gate bolts. Lock-bolts are usually operated by means of a key, while the last-mentioned are protruded and retracted by hand.

Bolts of the first class, — that is, for permanently fastening objects (and not mere sliding catches), may be distinguished, first, by their construction or mode of application; secondly, by their application.

As to construction, the difference may regard the shape of the head; as, *round, square, hexagon, octagon, saucered, countersunk-headed, clinch, collared, chamfered, diamond, convex,* etc.

Some structural peculiarity of the head; as, *eye, double-headed, hook, ring, T-headed,* etc.

The mode of securing; as, *screw, fox, forelock, clinch, rivet, rag, bay, barb, jag, key.*

As to the nature and purpose of their application they may be, — *assembling, fish, foundation, bringing-to, carriage, drive, fender, lewis, set, shackle, wagon-skein, tire, king, scarf, through,* etc.

The following list of bolts is approximately complete; it includes other than *holding*-bolts.

Assembling-bolt.	Holding-down bolt.
Barbed bolt.	Hook-bolt.
Bay-bolt.	Jagged bolt.
Bringing-to bolt.	Key-bolt.
Carriage-bolt.	Lewis-bolt.
Clinch-bolt.	Pointed bolt.
Countersunk-headed bolt.	Rag-bolt.
Diamond-headed bolt.	Ring-bolt.
Door-bolt.	Riveted bolt.
Drive-bolt.	Rose-headed bolt.
Eye-bolt.	Round-headed bolt.
Fender-bolt.	Scarf-bolt.
Fish-bolt.	Screw-bolt.
Flour-bolt.	Set-bolt.
Flush-bolt.	Shackle-bolt.
Forelock-bolt.	Square-headed bolt.
Foundation-bolt.	Shingle-bolt.
Fox-bolt.	Tire-bolt.
Half-turning bolt.	Wagon-skein bolt.

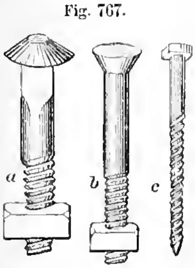
Assembling-bolt, one by which the separate portions of an object, made in detachable parts, are secured together; as the assembling-bolt of a gun-carriage.

A *barbed* or *jagged* bolt has prongs projecting exteriorly and backwardly.

A *bay*-bolt is barbed to prevent retraction.

A *bringing-to* bolt has an eye at one end, and a nut and screw at the other. It is used in keying up.

Fig. 767.



Bolts.

Carriage-bolts are of various kinds for different parts of the work.

a, *carriage*-bolt.
b, *tire*-bolt.
c, *wagon-skein* bolt.

A *clinch*-bolt is one whose point is turned over by hammering.

A *countersunk-headed* bolt is one with a conical head to fill a countersink (3, Fig. 768; *b*, Fig. 767).

A *diamond-headed* bolt is one whose head is shaped like a rhomb or lozenge.

A *double-ended* bolt (5, Fig. 768) is used for holding together three objects independently of each other. It has a thread and nut on each end.

A *drive-bolt* is a tool used by shipwrights and other wood-workers for setting bolts, etc., *home*; that is, *fixing* them, or giving them the last drive.

One used to expel another. A *drift*.

An *eye*-bolt or *eye-headed* bolt (6, Fig. 768) is used for securing a gland to a stuffing-box, or for other purposes, such as to receive a ring, lever, or rope.

A *fender*-bolt is one whose head projects so as to protect or fend off objects from the exposed surface which it unites to another.

A *fish*-bolt is one by which a *fish-bar* is fastened to a rail, as at the meeting-point of two railway rails.

A *flush*-bolt is one whose head is let down even with the surface (3, Fig. 768).

A *forelock* bolt is one having a slot in its end for receiving a key or cotter to prevent retraction.

A *foundation*-bolt is a long bolt holding a bed-plate down to the masonry or heavy framing substructure.

A *fox*-bolt is one with a split end into which a wedge is driven.

A *half-turning bolt* is one having a half-screw thread on one side and engaging in a similarly threaded socket. On pushing the bolt in and giving it a half-turn it becomes locked, and is unlocked by a corresponding reverse movement.

A *holding-down* bolt is similar to a foundation-bolt.

A *hook*-bolt is one with a hook-head.

A *jagged* bolt has barbs to the shank.

A *key*-bolt is secured by a cotter or wedge passing through a slot in the shank. Such an one is used in shipbuilding for securing the false keel. A *forelock* bolt.

A *lewis* bolt (7, Fig. 768) is used for fixing on to a block of stone; for this purpose a hole is cut in the stone large enough at the top to admit the thick end of the wedge-shaped bolt, which is barbed at the angles and run with lead.

The *pointed* bolt is a round bolt with an end that may be clinched.

A *rag*-bolt is one having a jagged end to prevent its being drawn out from timber, etc.

A *ring*-bolt is one which has an eye for receiving a ring.

A *riveted* bolt is one whose point end is battered and upset.

A *rose-headed* bolt is one whose head forms part of a sphere. The resemblance to the *rose* is very remote (4, Fig. 768).

A *round-headed* bolt has a head cylindrical or formed as a segment of a sphere.

A *scarf*-bolt is a shipbuilder's bolt used for securing the false keel.

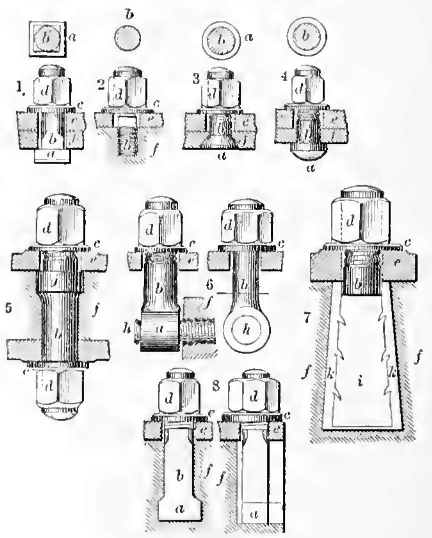
A *screw*-bolt is one having a screw-thread on the whole or a considerable portion of its length.

Bolts of bronze were used in ancient Egypt, but had no thread. One in Dr. Abbott's collection has the square head for turning.

There are many kinds.

1 is a *screw*-bolt having a square head *a*, a short round shank *b*, washer *c*, and nut *d*; by this screw-bolt the pieces *e f* are fastened together.

Fig. 768.



Screw-Bolts.

2 shows a *screw*-bolt in which the latter is tapped with the object *f*, and the portion *c* tightly fastened down thereon by the nut *d*.

3 has a *countersunk*-head which sinks into the body of *f* so as to become flush with the surface of the latter.

4 is a *round-headed* bolt which has a lip to prevent turning when the nut is screwed on or off.

5 is a *double-headed* bolt which has a nut on each end, and by which two pieces *c c* are secured to the portion *f*, whose recess holds the collar *g* of the bolt.

6 shows two views of an *eye*-bolt, represented as fastening a gland to a stuffing-box.

7 is a *lewis*-bolt whose barbed shank *i* is surrounded by lead *k* poured into the under-cut mortise in the block *f*.

8 shows two views of a T-headed bolt, to fasten a plate accessible only from one side.

A *set*-bolt is one used by shipwrights in closing up the planks.

A *shackle*-bolt is one having an eye for the insertion of a clevis, which is held by a pin and key.

The *square-headed* bolt has a quadrilateral head adapted to be grasped by a wrench.

The T-*headed* bolt is used to fasten against a plate which is only accessible from one side. In this case a slotted hole is made in the plate, of the size of the T head of the bolt, which is then passed through and turned round at right angles to the hole.

A *through*-bolt is one which goes *through* the pieces which are to be fastened together. Such are clinch-bolts, and bolts secured by nut and washer.

A *tire*-bolt is an ordinary nut and washer bolt, used for securing tires to the fellies of wheels. The nut and washer are applied on the interior of the felly, and the head countersunk into the tire. See *b*, Fig. 767.

A *wagon-skein* bolt is a peculiarly shaped bolt without a nut, and is used for fastening the skeins to the spindles of wagon-axles. (See *c*, Fig. 767.)

Rule for the computation of the weight of bolts: —

Wrought-iron: square the radius of the bolt, and multiply it by 10, the product will give the weight in pounds per foot.

Cast-iron: subtract from the above result $\frac{2}{27}$, or .074 of the result. — Horatio Allen.

The following standard for screw-threads, bolt-heads, and nuts has been adopted by the United American Railway Master Car-Builders' Association: —

Diameter of Bolt.	Number of Threads per Inch.	Diameter of Bolt.	Number of Threads per Inch.
$\frac{1}{4}$	20	2	$4\frac{1}{2}$
$\frac{5}{16}$	18	$2\frac{1}{4}$	$4\frac{1}{2}$
$\frac{3}{8}$	16	$2\frac{1}{2}$	4
$\frac{7}{16}$	14	$2\frac{3}{4}$	4
$\frac{1}{2}$	13	3	$3\frac{1}{2}$
$\frac{9}{16}$	12	$3\frac{1}{4}$	$3\frac{1}{2}$
$\frac{5}{8}$	11	$3\frac{1}{2}$	$3\frac{1}{4}$
$\frac{3}{4}$	10	$3\frac{3}{4}$	3
$\frac{7}{8}$	9	4	3
1	8	$4\frac{1}{4}$	$2\frac{7}{8}$
$1\frac{1}{8}$	7	$4\frac{1}{2}$	$2\frac{3}{4}$
$1\frac{1}{4}$	7	$4\frac{3}{4}$	$2\frac{5}{8}$
$1\frac{3}{8}$	6	5	$2\frac{1}{2}$
$1\frac{1}{2}$	6	$5\frac{1}{4}$	$2\frac{1}{2}$
$1\frac{5}{8}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$2\frac{3}{8}$
$1\frac{3}{4}$	5	$5\frac{3}{4}$	$2\frac{3}{8}$
$1\frac{7}{8}$	5	6	$2\frac{1}{4}$

The distance between the parallel sides of a bolt-head and a nut for a rough bolt shall be equal to one and a half diameters of the bolt plus one eighth of an inch.

The thickness of the heads for rough bolts shall be equal to one half the distance between their parallel sides.

The thickness of the nut shall be equal to the diameter of the bolt. The thickness of the head for a finished bolt shall be equal to the thickness of the nut.

The distance between the parallel sides of a bolt-head and nut, and the thickness of the nut, shall be one sixteenth of an inch less for finished work than for rough.

2. (*Locksmithing.*) That portion of a lock which is protruded beyond or retracted within the case or boxing by the action of the key, and which engages with the keeper or jamb to form a fastening.

The thick protruding portion is the *bolt-head*, and the flat part within the lock is the *bolt-plate*.

3. (*Household Hardware.*) A movable bar protruded or retracted by hand to fasten or release a door, gate, window-sash, etc. It is usually affixed to the movable object, and is received into a staple, box, or perforated plate attached to the post, jamb, or style, as the case may be.

Bolts are distinguished by

Shape; as, *square, round* (*e*), *flat* (*a*), *barrel* (*e*), etc.

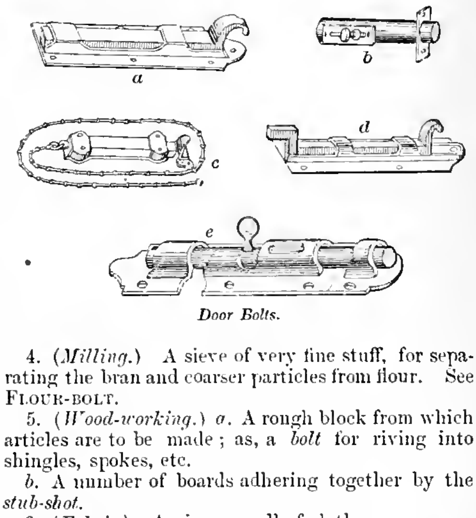
Purpose; as, *shutter, sash*, etc.

Construction; as, *chain* (*c*), *spring mortise* (*b*), *necked* (*d*), *dormant, catch, flush, drop*, etc.

Or by mere trade-names; as, *cottage, tower*, etc.

Some of the names are synonyms.

Fig 769.



Door Bolts.

4. (*Milling.*) A sieve of very fine stuff, for separating the bran and coarser particles from flour. See Flour-bolt.

5. (*Wood-working.*) *a.* A rough block from which articles are to be made; as, a *bolt* for riving into shingles, spokes, etc.

b. A number of boards adhering together by the *stub-shot.*

6. (*Fabric.*) A piece or roll of cloth.

A bolt of canvas is about 40 yards long, and the stuff is from 22 to 30 inches wide.

7. (*Nautical.*) The iron rod beneath a yard, to which a square sail is attached.

8. (*Ordnance.*) An elongated solid projectile for rifled cannon, as the Whitworth and Armstrong guns.

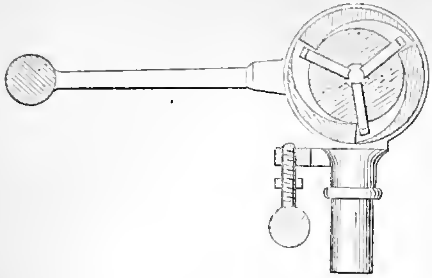
9. (*Bookbinding.*) The fold in the fore-edge and head of a folded sheet.

Bolt-au′ger. An auger used by shipwrights in sinking holes for bolts.

Bolt-chis′el. (*Machinery.*) A cold chisel for cutting off the extra length of a bolt. A cross-cut chisel. A deep chisel with a narrow edge.

Bolt-cut′ter. (*Machinery.*) *a.* A tool for cutting off bolts. It usually consists of a sleeve with a radial cutter setting inwardly and rotated around the bolt to be cut by means of a handle. In the example, the circular cutter-holder or hub is supported

Fig. 770.



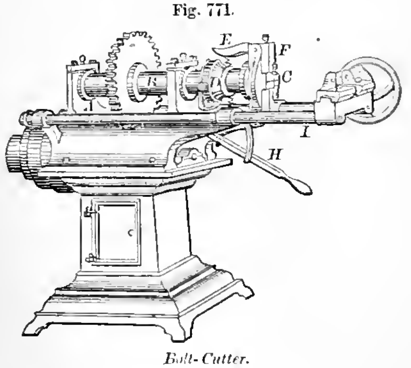
Bolt-Cutter

and partly inclosed by a thick ring with inwardly projecting flanges at the edges. The inner surface of this ring is divided into three sections, each of equal eccentricity to the hub, and against which the outer ends of the cutters abut; these are adjustable to or from the center, by rotating the hub in the proper direction by means of a handle attached thereto, the extent of whose motion is controlled by an adjustable stop formed by a set screw passing through an arm projecting from the standard on which the tool is supported.

b. A machine for cutting the thread on bolts. It consists of a framing *A* in which the revolving mandrel *B* works. This has the dies at one end *C*, which are operated as follows.

When the machine is started, the cone *D* is shipped up so that the ends of the levers *E*, resting on it, are raised. These levers being fastened, or

Fig. 771.



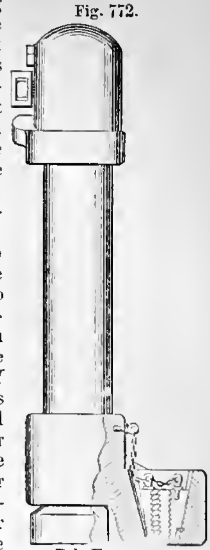
Bolt-Cutter.

having a fulcrum on the die-plate, depress the dies so that they may engage with the bolt to be cut; this is held between the jaws *F*, operated by the hand-wheel *C*. As soon as the bolt is cut, the handle *H*, when lifted, disengages the dies from the bolt, so that it can be taken back without running on the thread, thus saving time and avoiding injury. The mandrel *B* is hollow, and allows the bolt to enter it while the carriage is drawn along with the guides *I*.

The bolt-thread cutter adapted to the uses of the machinist is known as the *stock and dies*. Similar tools are used by gas-fitters, plumbers, and steam-fitters in threading the ends of the welded iron tubes now so much used in fitting houses with "all the modern conveniences." Some of these tools are made with two shanks like tongs, others with a stationary and a sliding jaw like a wrench.

Bolt-ex-tract'or. A tool or implement for extracting bolts by a lifting force. In the example, the hydraulic jack has a foot which has wedge-shaped jaws sliding in inclined slots within a cavity, whereby a great force may be applied in an advantageous manner, the line of draft being directly in the line of the axis of the bolt. The jaws have barbs to increase their grip on the bolt.

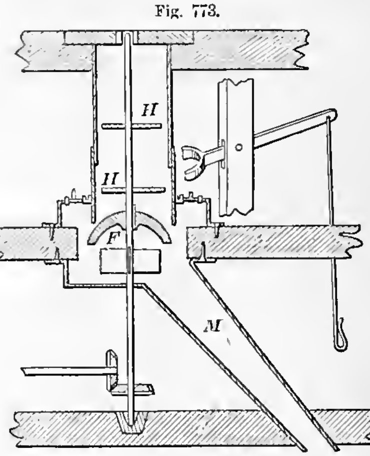
Fig. 772.



Bolt-Extractor.

Bolt-feed'er. (*Milling.*) A device for regulating the rate of passage of the meal to the flour-bolt. In the example, the meal is subjected in the cylindrical case to the action of the radial arms *H* of the rotating shaft. This shaft bears the saucer-shaped disk *F*, which stops the lower end of the cylinder. The lower section of the cylinder slides on the upper, and regulates the size of the annular exit-opening leading to the ventilating case containing the fan. From this case it passes to the chute *M*.

Fig. 773.

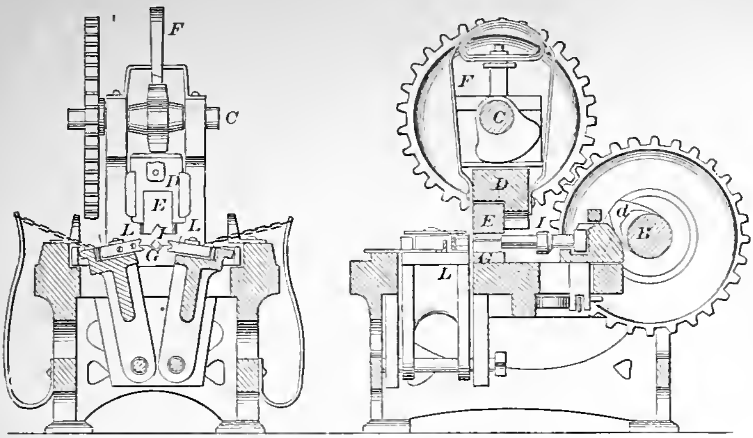


Bolt-Feeder.

Bolt-head. (*Glass.*) A long glass matrass or receiver with a straight neck.

Bolt-head'er. (*Machinery.*) A machine for swaging down the end of a bolt-blank to form a head; the form of this depends upon that of the die. In the example, the swinging holders *L L* cause the cutter to produce a drawing cut, and are made to move simultaneously with the die toward the bar, when the front end of the blank is cut off. The separated blank is then held by the holders, and its rear end is between the stationary die *G* and the reciprocating die *E*, when the punch *I* moves forward and heads the same. The holders and dies are then simultaneously drawn apart, and the finished bolt is released. The die *E*, in the holder *D*, is reciprocated by the cam or shaft *C*, and the recoil spring *F*; the punch is actuated by the cam *d* on the shaft *B*.

Fig 774.



Bolt-Heading Machine.

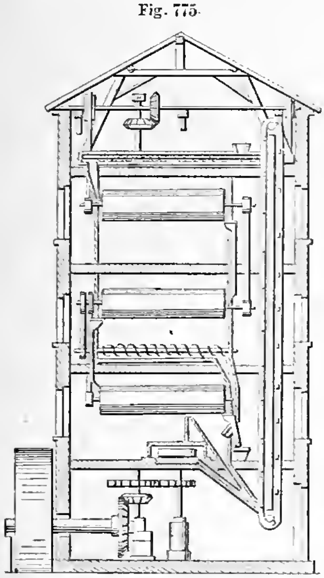
Bolt'ing-cloth. (*Milling.*) Cloth of hair or other substance with meshes of various sizes for sieves.

Bolt'ing-chest. (*Milling.*) The inclosure or case of a flouring-bolt.

Bolt'ing-hutch. (*Milling.*) A tub or box into which flour or meal is bolted.

Bolt'ing-mill. (*Milling.*) A machine in which flour is separated from the offal of various grades. The meal from the stones is passed through cylindrical sieves having meshes of varying degrees of fineness, at different parts of its length or through various sieves. In the illustration the several stones of the mill are shown; the meal from the stones passing down to the well of the elevator, which raises it to the upper bolt, from which it passes downward to others in succession.

Fig. 775.



Bolting-Mill.

Bolt-mak'ing Ma-chine'. (*Machinery.*) One in which bolts are threaded and headed, though this is usually done in separate machines, as the threading is done by cutters on the cold iron; heading by swaging upon the end of the hot blank. See BOLT-HEADER; BOLT-THREADER.

Bolt-rope. (*Nautical.*) A rope around the margin of a sail to strengthen it. It is

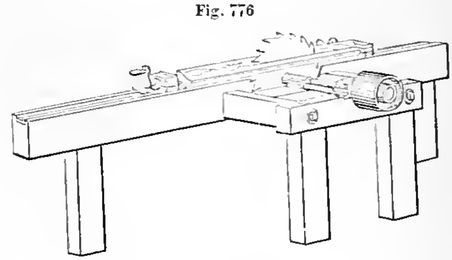
A *leech-rope*, up the sides.
A *head-rope*, along the top.
A *foot-rope*, at the bottom.

The *cringles* for bending-on the sail, and for the attachment of the reef-tackle, are worked in and around the *bolt-ropes.* See SAIL.

Bolt-rope Nee'dle. (*Nautical.*) A strong needle for sewing a sail to its bolt-rope.

Bolt-saw'ing Ma-chine'. (*Wood-working.*) For sawing superfluous wood, such as corners, from stuff to be turned. It has an iron carriage with centers between which the work is chucked while being fed to the circular saw. (Fig. 776.)

Fig. 776



Bolt-Trimming Machine.

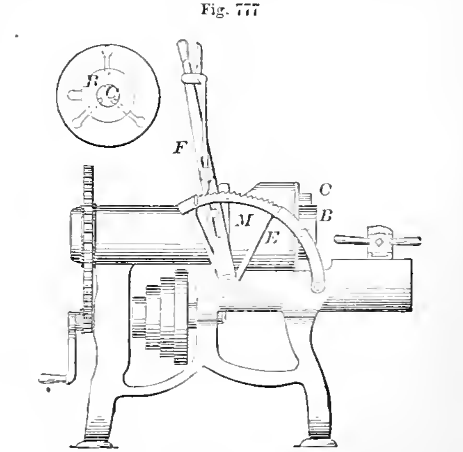
Bolt-screw'ing Ma-chine'. A machine for cutting screw-threads on bolts, by fixing the bolt-head to a revolving chuck, and causing the end which it is required to screw to enter a set of dies, which advance as the bolt revolves. A *bolt-threader.*

Bolt-sprit. (*Nautical.*) Another, now disused, name for BOWSPRIT (which see).

Bolt-strake. (*Shipbuilding.*) That strake or wale through which the beam-fastenings pass.

Bolt-thread'er. (*Machinery.*) A machine for cutting screw-threads on bolts. In that shown in Fig. 777, the head *E*, containing the cutters *C*, sur-

Fig. 777

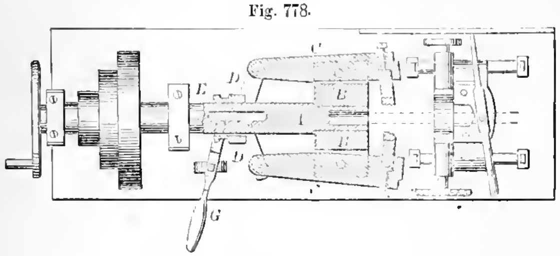


Bolt-Threader.

rounds the hollow mandrel *B*, and is reciprocated by means of the lever *F*, moving along the graduated arc *M*. As the head *E* is advanced, the fixed bolt enters the bore of the mandrel, and is threaded by the cutters *C*. The cutter-head may be rotated by hand or otherwise.

In Fig. 778, the bolt-head enters a rectangular recess in the longitudinally sliding stock. The dies are secured to jaws *C C* pivoted to the tubular spindle *B* of the head-stock. The forward ends of the jaws are brought together by toggle-levers at their rear ends. The toggle-levers *D D* are pivoted to a circumferentially grooved collar *E*, turning with the mandrel *A*, but slid thereon by a hand-lever *G*.

Fig. 778.



Bolt-Threader.

Bomb. (*Ordnance.*) A spherical hollow shot, fired from a *mortar* or *howitzer*, and filled with explosive material which is lighted by a *time* or *percussion fuse*.

Bombs were used at the siege of Naples in 1434. Mortars for bombs were cast at Buckstead, England, 1543. See Shell.

Bom'bard. (*Ordnance.*) An ancient mortar of large bore, used to throw stone shot.

Bom'bar-do. (*Music.*) A wind-instrument like a bassoon, and used as a base for the oboe.

Bom'ba-zine. (*Fabric.*) A mixed silk and woolen twilled stuff. The warp is silk and the weft worsted.

Bomb-chest. A box filled with explosive projectiles or materials, and buried in the earth, in military mining.

Bomb-ketch. (*Vessels.*) A small, strongly built vessel, ketch-rigged, on which one or more mortars are mounted for naval bombardments.

Mortar-vessels are said to have been invented by Reyneau, and to have been first used at the siege of Algiers in 1682.

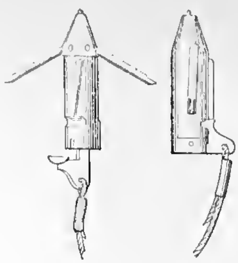
Bomb-lance. A harpoon which carries a charge of explosive material in its head. In the example, the head is charged with powder, and when the harpoon penetrates the fish, the bar which is pivoted obliquely in the head serves to release the spring-actuated hammer, which explodes the cap and bursts the charge-chamber.

Fig. 779.

Bomb-Lance.

A form of bomb-lance which has been very successful is shown in Fig. 780. It is a cast-iron tube about 12 inches long and 1 inch diameter, carrying in a charge-chamber 100 grains of gunpowder. It is fired from a gun, and the match is lighted in the act of firing. Prongs fly out from the tube to prevent retraction of the missile.

Fig. 780.



Harpoon-Ball, or Bomb-Lance.

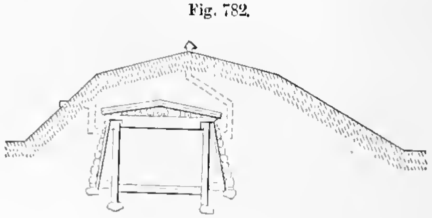
Fig. 781.

Bomboto.

Bom'bo-lo. (*Glass.*) A spheroidal retort in which camphor is sublimed. It is made of thin flint-glass, weighs about one pound, and is 12 inches in diameter. It is heated in a sand-bath to 250° Fah., which is gradually increased to 400°. For the details of the operation, see Ure; Camphor.

Bomb-proof. (*Fortification.*) A structure in a fortification which is so covered with earth as to be secure from the penetration of cannon-balls by the ordinary or plunging fire. It may be a structure of stone, brick, or wood, but must have strength to bear a heavy load of earth, which converts it into a mound in which shot are buried without penetrating to the interior.

Fig. 782.



Bomb-Proof.

Bomb-shell. A spherical or cylindrical case of iron loaded with powder, and burst by its charge on concussion or after an interval of time. See Shell.

Bo-na-ven'ture-miz'zen. An additional or second mizzen-mast, formerly used in some large ships.

Bond. That part or those parts of a built structure which tie the other portions together.

1. (*Masonry.*) A stone or brick which is laid with its length across a wall, or extends through the facing course into that behind, so as to bind the facing to the backing. Also known as *binders; bond-stones; binding-stones; through-stones; perpend-stones, header.*

Perpend signifies that a heading-stone passes through the whole thickness of a wall.

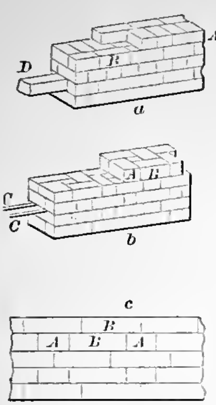
Binder, that it extends a part of the distance across.

Heart-bond, in stone-walling. In this there are no perpend-stones, but two headers meet in the middle of the wall, and the joint between them is covered by another header.

Chain-bond is the building into the masonry of an iron chain or bar, or heavy scantling.

Cross-bond. A block-bond in which the joints of the second stretcher-course come in the middle of the first; a course of header and stretcher intervening. See *c*, Fig. 783.

Fig. 783.



Wall-Bonds.

Block and cross bond. The extrados of the wall is put up in *cross-bond*; the intrados in *block-bond.*

2. (*Bricklaying.*) A particular mode of disposing bricks in a wall so as to tie and break joint.

The *English bond* (*a*) has courses of headers alternating with courses of stretchers.

In the *Flemish bond* (*b*) each course has stretchers and headers alternately.

A, header.
B, stretcher.
C, bond of hoop-iron.
D, timber-bond.

3. (*Roofing.*) The distance which the tail of a shingle or slate overlaps the head of the second course below. A slate 27 inches long, and having a *margin* of 12 inches *gage* exposed to the weather, will have 3 inches *bond*, or *lap*. The excess over twice the *gage* is the *bond.*

4. (*Carpentry.*) Tie-timbers placed in the walls of a building; as bond-timbers, lintels, and wall-plates.

Bond-pa'per. A thin, uncalendered paper made of superior stock, and used for printing bonds and similar evidences of value.

Bond-stone. (*Masonry.*) A stretcher used in uncoursed rubble-work; if inserted the whole thickness of the masonry, it is called a *perpend* or perpend-stone.

Bond-tim'ber. (*Bricklaying.*) One put lengthwise into a wall to bind the brickwork together, and distribute the pressure of the superincumbent weight more equally. It also affords hold for the battens, which serve as a foundation for interior finishing.

Bone. 1. (*Surveying.*) To sight along an object or set of objects to see if it or they be level or in line.

2. Physiologically speaking, the material of the skeleton or framework of the body.

Chemically considered, a compound of animal and earthy matters, the latter giving rigidity to the cellular tissue.

Mechanically considered, the uses of bone are for turning, inlaying, handles of knives and tools, billiard balls, scales, etc. The term includes the ordinary bones of the body, and also the tusks and teeth of the elephant, hippopotamus, walrus, and whale.

Bone is also, when deprived of its animal matters by distillation, used as a defecating, bleaching, and filtering material in the treatment of sirups and distilled liquors, and in the purification of water. Bone-black is also used as a pigment in making printer's ink.

Bone, while yet fresh, is used by pastry-cooks to prepare a clear and rigid jelly.

Bone is used by steel-workers as a carbon in the hardening of steel.

Whalebone (so called) is not a bone, but partakes of the nature of horn. See BALEEN.

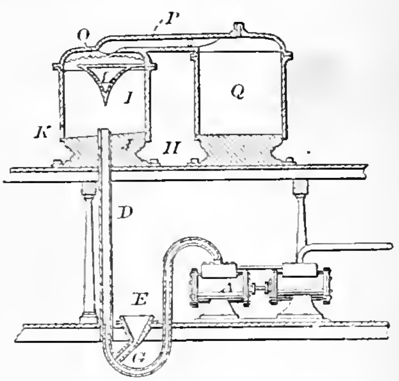
Bone is used by husbandmen as a manure.

Bones blanched in an open fire, removing the carbon, yield a powder which is used in making the cupels of the assayer, in making phosphorus, and as a polishing material.

Bone-black. Produced by calcining the bones or ivory of animals in close vessels. This process leaves the animal charcoal, consisting of the earthy and saline portions of the bone, combined with carbon, while the volatile matters are distilled over. Among these products is a peculiar oil, which is burned in lamps in close chambers; the soot which accumulates on the sides is collected, and forms the pigment known as bone-black or ivory-black, according to quality.

Bone-black Clean'ing-ap'pa-ra'tus. A device for purifying, screening, and cooling bone-black after treatment in the revivifying retort. In Hanford's apparatus the hot bone-black from the furnace

Fig. 784.



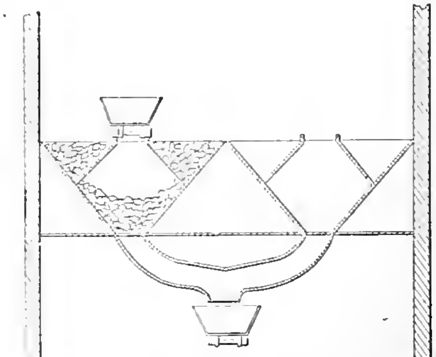
Hanford's Bone-Black Cleaner.

is received in a hopper *E*, driven by force of air from the pump *A* through the pipe *D*, is received in a closed chest *I*, having an inverted conical perforated deflector *L*, which directs the larger masses downward, where they are discharged by the slanting floor and opening *K*. The smaller particles and dust are carried by the blast of air through the openings in the conical screen *L*, the second screen *O*, and the pipe *P*, to the next chamber *Q*. A jet of steam is injected into the pipe *P*, so as to damp the dust in passing and assist in its deposition.

Bone-black Cool'er. An apparatus for cooling animal charcoal after its removal from the furnace.

The hot, reburnt coal is poured into hoppers, passed through an annular opening, and then through pipes into a car. The plates against which it passes

Fig. 785.



Bone-Black Cooler.

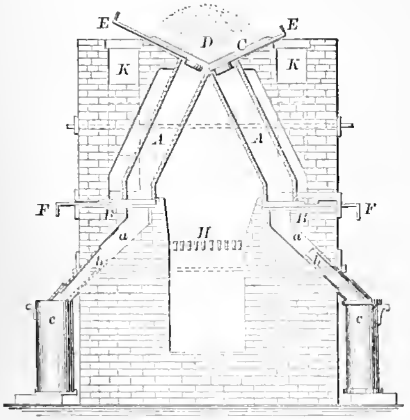
are kept cool by a current of cold air through a surrounding channel. The tops of the plates may be arranged so as to form a railroad-car track, over which trucks containing the hot coal may travel.

Bone-black Fur'nace. No material equal to bone-black has yet been discovered for decolorizing and purifying saccharine solutions. After a certain quantity of sirup has been filtered through it, it is necessary to revive it by removing the gum, sugar, and other vegetable extract that has filled its pores and deprived it of its useful qualities. Some of these matters, such as gluten, are not soluble in water until after fermentation, or an equivalent chemical treatment. The practice has been to suffer the bone-black to ferment in a heap, to decompose the organic matter, after which it is washed, dried, and recalcined, acquiring again its full decolorizing powers, but having lost a portion, due to the crumbling in the various processes through which it is passed. This is calculated by Fleischman to be from 12 to 15 per cent per annum; by an English author, to be 6 per cent on each turning; and by a writer in Harper, who has studied the economy of the Cuban systems, at 10 per cent for each use, which is probably an extreme calculation. Much depends upon the system adopted in its revivification. This is done in several ways: —

1. Calcination in iron pots.
2. Calcination in retorts; horizontal or vertical.
3. Purging by highly heated steam.
4. Roasting in open revolving-cylinders.
5. Washing in dilute hydrochloric acid.
6. Washing in a dilute lye of potash or soda.

Fig. 786 shows one form of furnace for revivifying bone-black, in which the bone-black *D*, charged with impurities, is deposited in the hopper *C*, where the withdrawal of slides *E* permits it to fall into the tubes *A A*, which are exposed to the heat from the furnace-

Fig. 786

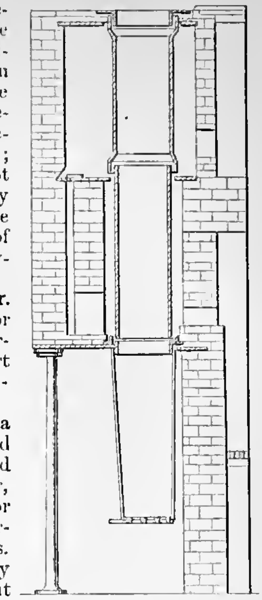


Bone-Black Furnace.

grate *H* until the impurities are discharged, when, by withdrawing the slides *F F* on the bottom-plates *B B*, it passes into the tubes *a a b b*, and is received into the vessels *c c*. *K K* are flues for conducting off the products of combustion and partially drying the black before it is admitted to the tubes *A A*.

Bone-black Kiln. A chamber or retort mounted in a furnace for re-burning bone-black to remove impurities with which it has become saturated or impregnated during its use as a defecator and filtering-material. Eastwick's bone-black kiln has a retort in three lengths, each supported separately, so as to prevent the weight of the whole column from bending the lower section when heated to redness. The upper section is the receiving; the middle section has the greatest heat; the lower section is not immediately affected by the fire, and forms the cooler. At the foot of the latter is a draw-damper for discharge.

Fig. 787.



Bone-Black Kiln.

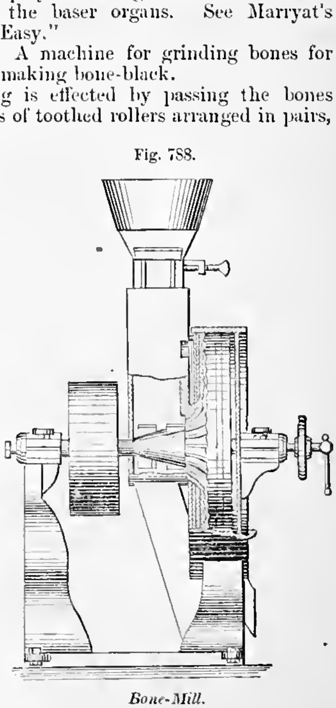
Bone-el'-e-va'tor. (*Surgical.*) A lever for raising a depressed portion of bone, as a part of the cranium, for instance.

The boys' "sucker," a wet disk of leather applied to the part and then raised by a string in the center, has been suggested for raising depressed portions of fractured skulls. Ewbank humorously suggests that it might be used to cause a development of the finer organs of the brain by application over those phrenological regions deserving of encouragement. In this, however, Nicodemus Easy was considerably ahead of Mr. Ewbank, for the old gentleman had a complex machine where suction and pressure had each its part to play in raising the finer sentiments and depressing the baser organs. See Marryat's "Midshipman Easy."

Bone-mill. A machine for grinding bones for fertilizer or for making bone-black.

Bone-grinding is effected by passing the bones through a series of toothed rollers arranged in pairs, the rollers being toothed or serrated in different degrees of fineness, and riddles are provided for sifting the bones into sizes, and they are then sold as inch, three-quarters, half-inch, and dust.

Fig. 788.



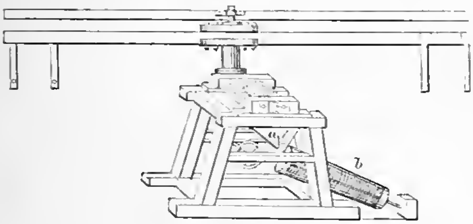
Bone-Mill.

The mill shown in Fig. 788 is made of iron, and is bolted to a foundation. Bones placed in the hopper fall through the chute, and are broken by a crusher at its bottom. They thence pass between a stationary grinding-plate and a revolving grinding-plate *B C*, turned by the axis and pulley *E*, faced with hollowing diamond-shaped projections arranged in lines radiating from the center. While these are dulled at one edge by constantly turning the mill in one direction, they are sharpened at the other, and the motion of the mill is reversed, bringing the latter into action. The plate *B C* is adjusted to grind to any degree of fineness, by means of the screw-wheel and hand-lever shown at *A*.

An English bone-mill has a pair of rollers with circular, square-edged grooves, like those of a rolling-mill, the salient faces of the teeth being serrated and meshing with those of the opposite roll. The plumber-block of one roll is adjustable, so as to vary the distance between the rolls for large or small bones.

The machine is driven by two horses attached to the sweeps, and the bones are passed through several

Fig. 789.



Bone-Mill.

times, the rolls being set up a little each time by means of set screws. The bones, after passing between the rolls, are conducted by the hopper *a* into a revolving screen *b*, which is driven by a bevel-wheel working into a pinion on the screw-shaft.

"Hadrian (whose bones may they be ground and his name blotted out!) [he had rebuilt Jerusalem under the name Ælia Capitolina, dedicated it to Jupiter, and forbade a Jew to enter the city under pain of death] asked Rabbi Joshua Ben Hannaiah, 'How doth a man revive again in the world to come?' He answered and said, 'From *Luz*, in the backbone.' Saith he to him, 'Demonstrate this to me.' Then he took *Luz*, a little bone out of the backbone, and put it in water, and it was not steeped; he put it into fire, and it was not burnt; he brought it to the mill, and that could not grind it; he laid it on the anvil and knocked it with a hammer, but the anvil was cleft and the hammer broken."

Bones. (*Music.*) A musical instrument, if it may be so called, by which the rhythmical beat of a tune is maintained in the manner of castanets. The name is derived from the material originally used. A pair of bones or small wooden maces is held in the hand and separated by a finger, so that the protruding ends may tap against each other, and give a sharp snapping sound. The raps are governed by the play of the hand.

The *bones* are the usual accompaniment of the sable harmonists, and the instrument is popularly supposed to be of negro origin. It is a legitimate African tinkler, having been used in ancient Egypt as far back as the prosperous Theban era. Round-headed pegs (*crotala*) were held between the fingers of the dancers in the festivities of Herculaneum, and used after the manner of the modern *bones* by rattling in the hand. The maces of the ancient Egyptians were metallic and sonorous; those of the Japanese are of wood. The effect desired is or was substantially the same in the cases cited. A sharp snap to beat the measure, audible above the hum of the people, the rub-a-dub of the little drums, the clapping of hands, the twanging of the stringed and whistling of the wind instruments. *Castanets, maces, sonnettes, cymbals*, are different forms of striking instruments. See CASTANETS; DRUM.

Bon-grace. (*Nautical.*) A bow-grace or junk-fender.

Bon'ing. (*Surveying.*) The operation of leveling by means of the eye.

Bon'ing-stick. (*Building.*) A stick with a head like the letter T, to indicate a level for work or construction. A number of such sticks over a site indicate a certain level for the tops of base pieces or foundation-blocks.

Boning, in carpentry or masonry, is performed by placing two straight edges on an object and sighting on their upper edges to see if they range. If they do not, the surface is said to be *in wind*.

Bon'net. 1. (*Wear.*) A lady's head-gear, having a crown and a curved brim displayed upward and forward.

2. (*Fort.*) A portion of a parapet elevated to a traverse to intercept enfilade fire.

3. (*Machinery.*) *a.* A cast-iron plate covering the openings in the valve-chamber of a pump, and removable for the examination and repair of the valve and seat.

b. A metallic canopy or projection, as of a fireplace or chimney. A cowl or wind-cap. A hood for ventilation, or the smoke-pipe on a railway-car roof.

c. The dome-shaped wire spark-arresting cover of a locomotive chimney.

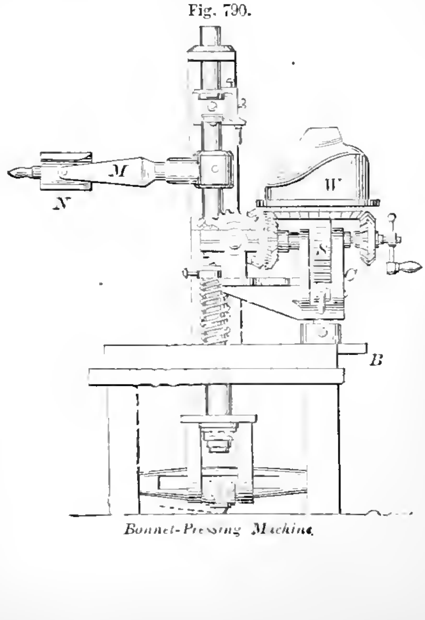
4. A sliding lid for a hole in an iron pipe.

5. (*Nautical.*) An additional piece of sail added by lacings to the foot of a jib, or a schooner's foresail. It is used during light winds.

Bon'net de Prêtre. (*Fortification.*) Called also priest's cap or swallow-tail. A *double redan*. See REDAN.

Bon'net-shap'ing Ma-chine'. A machine in which a partially shaped bonnet is pressed down upon a forming-block, to give it a set shape. One die has the exterior, the other the interior shape; one is usually heated so as to dry the bonnet and make it rigid in its acquired form. The proress and machine are similar to the hat-forming machine, the difference being principally in the shape of the article. See HAT-FORMING MACHINE.

Fig. 790.



Bonnet-Pressing Machine.

Bon'net-press'ing Ma-chine'. A machine by which bonnets while on the forming-block are presented to the flat or presser. In the example, the bonnet is placed crown upward upon the former *W*, which has a rocking adjustment by the ratchet *S* upon a frame *C*, whose pedestal is planted on the slide *B*, which has a traversing motion to bring the former and the bonnet beneath the presser *N* on the end of the horizontal arm *M*. This has a pressure, by means of springs, on the stem, while the *former* is rotated beneath the pressing-iron by means of the hand-crank and bevel-gearing.

Bon'ney. (*Mining.*) An isolated bed of ore.

Bon'ten. (*Fabric.*) A narrow woolen stuff.

Boo'by-hatch. (*Nautical.*) The covering of the scuttle-way or small hatchway which leads to the forecastle or *fore-peak* of small sailing-vessels.

Boo'by-hut. (*Vehicle.*) A sleigh with a hooded cover.

Boo'by-hutch. (*Vehicle.*) A roughly built covered carriage, used in some parts of England.

Book. 1. A number of sheets of paper bound together on edge, known as the *binding-edge*.

Anciently, books consisted of a continuous roll formed by pasting or glueing sheets of parchment or papyrus together. They were usually furnished with cases into which they were placed for preservation when not in use. See PAPER.

Before the discovery of papyrus — which, however, was at a very distant period — inscriptions were made on boards, inner bark of trees, afterwards on skins. Books with a back and leaves of vellum were made by Attalus, King of Pergamus, about 198 B. C. See PARCHMENT.

The manuscript rolls in Herculaneum consist of papyrus, which is charred and matted together by the fire. The rolls are nine inches long, and vary in diameter; each forms a separate treatise. The first printed books were printed on one side only, and the pages pasted together at the backs.

Pliny says that the Parthians write upon cloths. Livy speaks of books of linen inscribed with the names of magistrates and the history of the Roman Commonwealth, and preserved in the temple of the Goddess Moneta.

Aristotle is said to have been the first to collect a library with a general assortment of books. (STRABO.) Pisistratus of Athens and Polycrates of Samos had libraries, supposed to have been principally poetical works.

The public library of Pisistratus was removed to Persia by Xerxes.

The library of Alexander was kept in two precincts of the city, the Brucheion and the Serapeum. It contained from 400,000 to 700,000 books. Authorities (Gellius, Josephus, and Seneca) differ. Ptolemies Soter, Philadelphus, and Euergetes were its patrons. Philadelphus added the famous library of Aristotle to the collection. It was much injured by fire in the siege of Julius Cæsar. Antony added to it the library of Pergamus, collected by Eumenes. It was afterward injured by Theodosius, and destroyed by the Arabs, A. D. 640.

The first public library of Rome was founded by Asinius Pollio, on Mt. Aventine. This was followed by the libraries of Augustus, Octavia, and Tiberius. The Ulpian library of Trajan was attached by Diocletian to his thermæ.

A furnished library was discovered in Herculaneum. Round the wall it had numbered cases containing the rolls.

It is recorded that Plato bought three works of Philolaus, the Pythagorean, for ten thousand denarii, nearly $ 1500. Aristotle bought a few books of Speucippus for three Attic talents, nearly $2800. Jerome, A. D. 420, states that he ruined himself by buying a copy of the works of Origen. Alfred the Great gave an estate for one on cosmography, A. D. 872.

The book of St. Cuthbert, the earliest ornamental book, is supposed to have been bound about A. D. 650. A Latin Psalter in oak boards was bound in the ninth century.

In more modern times, Machlin's Bible, ornamented by Tomkins, was valued at £ 525. A superb copy of the Bible was printed and collected by Mr. Parker, of Golden Square, London, in about 54 large folio volumes, with 7,000 illustrations in the text and mounted, and containing original drawings by Louthrbourg and others, was insured in a London office for £ 3000. It was raffled off at £ 5000; 100 subscribers at £ 50 each. Two wagon-loads of a book at $ 25,000.

A standard dictionary of the Chinese language, containing 40,000 characters, was made by Pa-outshe about 1100 B. C. (MORRISON.) The Onomastikon, a Greek dictionary of Julius Pollox, was written about 120 B. C.

Sze-ma-tseen, the Chinese Herodotus, wrote in the second century B. C. The dictionary Si-wun was compiled about 148 B. C.

The Spanish Saracens compiled dictionaries, lexicons, encyclopedias, and pharmacopœias. The Historical Dictionary of Sciences of Mohammed Ibu Abdallah, of Granada, is a notable instance. Avicenna also wrote a large number of works, among them an Encyclopedia of Human Knowledge, in twenty volumes.

A manuscript copy of the Evangelists, the book on which the English kings, from Henry I. to Edward VI., took their coronation oath, was bound in oak boards, nearly an inch thick, in 1100.

Velvet was the covering in the fourteenth century. Silk soon after. Vellum in the fifteenth. It was stamped and ornamented about 1510. Leather came in use about the latter date. Cloth binding superseded the common paper-covered mill-boards about 1831. Caoutchouc backs to account and other heavy books were introduced in 1841. The rolling machine of William Burr (England) was substituted for the beating-hammer about 1830. See BOOKBINDING.

2. (*Gilding.*) A package of gold-leaf, consisting of 25 leaves, each $3\frac{1}{2} \times 3$ inches square; they are inserted between leaves of soft paper rubbed with red chalk, to prevent adherence.

Book-back Round'er. 1. (*Bookbinding.*) A machine which acts as a substitute for the hammer in rounding the back of the book after cutting the edge and ends. It is usually performed upon the book before the cover is put on.

In one form of machine, the book is run between rollers, being pressed forward by a rounded strip which rests against the front edge and determines the form thereof.

In another form, the book is clamped and a roller passed over the back under great pressure.

Another form of machine is for molding the back-covers of books to a given curvature, by pressing between a heated cylinder of a given radius and a bed-plate whose curvature corresponds to the presser.

Book-bind'er. A contrivance of the nature of a temporary cover, for holding together a bunch of newspapers, pamphlets, or similar articles. There are many forms of the device.

Book-bind'er's Tools, etc. See under the following heads: —

Album.	Arming-press.
All-along.	Backing-board.

Back-tools.
Band.
Band-driver.
Bead.
Beveling-machine.
Binding.
Bleeding.
Blind-blocking.
Blind-tooling.
Blocking.
Blocking-press.
Board.
Book (gold-leaf).
Book-back rounder.
Bookbinder.
Book-clamp.
Book-folding machine.
Book-sewing machine.
Boss.
Case.
Case-work.
Corner.
Covering.
Creaser.
Cropped.
Cutting-press.
Dentelle.
Edge-bolt.
Edge-cutting.
Edging.
Embossing.
Fillet.
Finishing-press.
Flexible binding.
Folding.
Folding-machine.
Fore-edge.
Forel.
Forwarding.
Foundation-plate.
Full-bound.
Gather.
Gilding-tool.
Glaire.
Glueing-machine.
Glueing-press.
Gouge.
Grater.
Guards.
Half-binding.
Hand-letter.
Head.
Head-band.
In-boards.
Inside-tin.
Interleave.
Joint.
Kettle-stitch.
Knocking.
Lacing.
Law-binding.
Laying-on tool.
Lettering-box.
Lettering-tool.
Marble-edge.
Marbling.
Mill-board.
Mitered.
Overcasting.
Pallet.
Panel.
Pawl-press.
Plow.
Pocket-book.
Point.
Polishing-iron.
Polishing-tin.
Porte-monnaie.
Portfolio.
Press-keys.
Roll.
Rolling.
Rolling-press.
Rounding.
Run-up.
Scratcher-up.
Screw-press.
Sewing.
Sewing-table.
Shaving-tub.
Signature.
Slip.
Square.
Stabbing machine.
Stamp.
Steamboating.
Stitching.
Stove, Bookbinder's
Tip.
Tooling.
Tools.
Turning-up.
Whipping.

Book-bind'ing. The art of attaching together and covering the sheets composing a book.

The earliest known forms of bookbinding, if the term be held to include all modes of attaching sheets together, is perhaps the Egyptian, which consisted in pasting or glueing the sheets together and rolling them upon small cylinders. The sheets were unrolled from one cylinder, and, after reading, rolled upon the other. The copy of the Pentateuch, in the possession of the small band of Samaritans yet living at Nablous, the ancient Gerizim, is thus preserved. It is claimed by its possessors to have been written by a grandson of Aaron. The book of the law in all synagogues is thus mounted.

Another ancient mode, the precursor of the more modern system, is found in the mode of stringing leaves together by several cords passing through holes near one edge. This is practiced in India with pieces of leaves neatly cut to a size. See PAPER; PEN.

The present plan of fastening the leaves to a back and sides is believed to have been invented by Attalus, of Pergamus, or his son Eumenes, about 200 B. C. This king, or somebody for him, invented parchment, hence called *pergamena*, from Pergamus. It was devised as a substitute for papyrus, on which an embargo had been laid by Ptolemy of Egypt, who thus sought to embarrass the rival library in Asia Minor.

The oldest bound book known is the volume of St. Cuthbert, *circa* 650.

Ivory was used for book covers in the eighth century; oak in the ninth. The "Book of Evangelists," on which the English kings took their coronation oath, was bound in oak boards, A. D. 1100.

Hog-skin and leather were used in the fifteenth century.

Calf in 1550.

Silk and velvet as early as the fifteenth century.

The Countess of Wilton, in her "Art of Needlework," says the earliest specimen of needlework-binding remaining in the British Museum is Fichetus (Guil.) Rhetoricum, Libri tres (Impr. in Membranis), 4to, Paris ad Sorbonæ, 1471. It is covered with crimson satin, on which is wrought with the needle a coat of arms, a lion rampant in gold thread in a blue field, with a transverse badge in scarlet silk; the minor ornaments are all wrought in fine gold thread.

The next in date in the same collection is a description of the Holy Land, in French, written in Henry VII.'s time. It is bound in rich maroon velvet, with the royal arms, the garter, and motto embroidered in blue, the ground crimson, and the fleurs-de-lis, leopards, and letters of the motto in gold thread. A coronet of gold thread is inwrought with pearls; the roses at the corners are in red silk and gold. In the Bodleian Library is a volume of the Epistles of St. Paul (black letter), the binding of which is embroidered by Queen Elizabeth; around the borders are Latin sentences, etc. Archbishop Parker's "De Antiquitate Britannicæ Ecclesiæ" (1572), in the British Museum, is bound in green velvet, embroidered with animals and flowers, in green, crimson, lilac, and yellow silk, and gold thread.

A folio Bible which belonged to Charles I., date 1527, is now preserved in the church of Broomfield, Essex, England. It is bound in purple velvet, the arms of England embroidered in raised work on both sides.

A will of 1427 devises several psalters in velvet bindings.

Cloth binding superseded the paper known in England as "boards" in 1823.

India-rubber backs were introduced in 1841.

Tortoise-shell sides in 1856.

Three fine specimens of old bookbinding are in the collection of James S. Grinnell, of Washington, D. C., and deserve notice as being representative of different styles.

1. A manuscript breviary of the fourteenth century, elaborately illuminated on parchment, has a brown calfskin cover over sideboards of beech, the bands being of calfskin passed through holes in the boards and wedged. The cover is elaborately blind-tooled, that is, not gilded, but worked by pressure and heat. The designs are in square panels of geometric figures.

The book is bound in folded signatures of five double sheets, making twenty pages to a signature, and the first letter on each of these parcels is written at the bottom of the previous parcel for the direction of the binder.

The book had brass clasps, and contains the "divine office" for the year. It is in remarkable preservation.

2. "Catalogus factorum et gestorum eorum et

diversis voluminibus collectus," edited by "the most reverend father in Christ, Petro de Natalibus." Printed in 1514.

Bound in white vellum, elaborately embossed with salient figures representing Faith, Hope, and Charity, kit-cat length in panels of the cover, surrounded by scrolls and leafage. The binding has the date of 1595, and the vellum was evidently embossed by being stamped while wet with dies engraved in *intaglio.* The panel borders were made by hand-tool fillets, not rolls. The figures are repeated in a manner which shows that the impressions are repetitions of the same stamp. The vellum was probably laid upon a material which would yield somewhat to pressure and then retain its form. The vellum was then dried in position.

3. A copy of John Minsheu's folio dictionary "Ductor in Linguas," published in 1617, and dedicated to James I. It was formerly in the library of Charles I., is bound in buff leather, and has the arms and crown on both sides of the cover.

The binding of books varies, and the following names occur: —

Full-bound; back and sides leather.

Half-bound; back leather, sides paper or cloth.

Cloth; back and sides covered with a colored fabric, usually embossed.

Muslin; same as above.

Boards; an English term. The covers were of mill-board. They were afterwards covered with paper.

Other modes are known by the kind of leather with which they or their backs are *full* or *half* bound; as, Russia, morocco, roan, calf, sheep, vellum, etc.

In one form of caoutchouc binding, the sheets are folded in double leaves, clamped, treated on the back with several coats of caoutchouc in solution.

The processes of bookbinding are about as follows:

Folding the sheets.

Gathering the consecutive signatures.

Rolling the packs of folded sheets.

Sewing, after saw-cutting the backs for the cords.

Rounding the backs and glueing them.

Edge-cutting.

Binding; securing the book to the *sides.*

Covering the sides and back with leather, muslin, or paper, as the case may be.

Tooling and *lettering.*

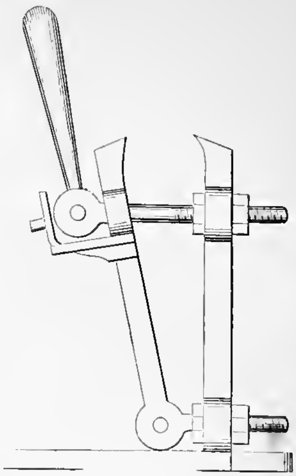
Edge-gilding.

The British Museum Catalogue is a library of folios in itself. Every volume is stoutly bound in solid blue calf, with its lower edges faced with zinc, to save wear and tear from the violent shoving in of the volumes to their places.

The museum at Cassel, in Germany, has a collection illustrating European and other trees. It is in the form of a library, in which the back of each volume is furnished by the bark of some particular tree, the sides are made of perfect wood, the top of young wood, and the bottom of old. When opened, the book is found to be a box, containing either wax models or actual specimens of the flower, fruits, and leaves of the tree.

At a sale of rare books and manuscripts in Paris recently, there was disposed of a fourteenth century, illuminated, Gothic edition of the Bible, with gold clasps, set with turquoises and bound in human skin. A copy of the "Imitation of Christ," now in the Carmelite library at Paris, is similarly covered. The human skin is said to preserve its brilliant whiteness forever, while all other parchments will turn yellow. It possesses, besides, the advantage of being easily embossed, the Bible in question being beautifully ornamented with *fleurs de lys,* scepters, etc. On the other hand, it absorbs ink so freely that it is impossible to write upon it. The character of the skin is determined by the microscope. The human skin and its hair are readily distinguished from those of other animals.

Fig. 791.

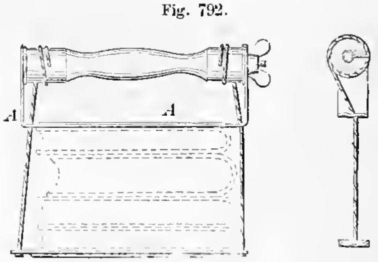


Book-Clamp.

Book-clamp. (*Bookbinding.*) *a.* A vise for holding a book while being worked. Adjustment is made by the nuts for the thickness of the book, and the pressure is given by the lever and eccentric.

b. A holder for school-books while carrying them. The cords pass through the upper bar *A* and down to the lower bar; they are tightened by the rotation of the handle.

Fig. 792.



School-Book Clamp.

Book-edge Lock. A lock whereby the closed sides of the book-cover are locked shut.

Book-fold'ing Ma-chine'. A machine for folding sheets for gathering, sewing, and binding.

Chambers's book-folding machines are made of various sizes, adapted to fold sheets to various dimensions from folio downward.

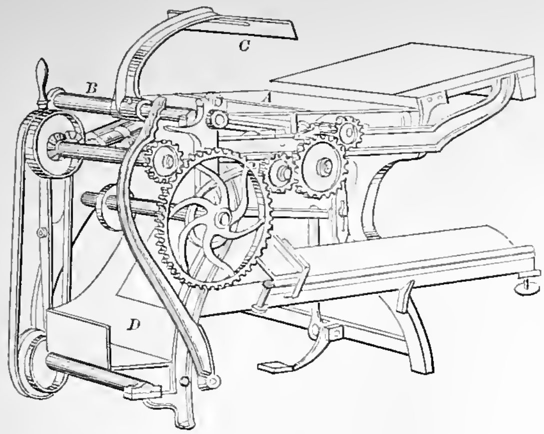
They are also adapted for folding two separate sheets together, pasting the separate pages at the back; or for cutting sheets into a number of pieces and folding them separately. Insets also may be cut off and set in as by hand.

Fig. 793 will give an idea of the folding process on a simple machine.

The operator transfers a sheet to the table *A*, which has a transverse slit across its middle. The revolution of the pulleys operates a rock-shaft *B*, carrying a curved arm with a folder *C* at its extremity, which presses the sheet down through the slit in the table, where it passes between rollers, which double it and deliver it into a receptacle *D*, at the end of the machine.

To fold an octavo, the once folded sheet is again presented to a folding edge, when it is carried to a second set of rollers, which squeeze it flat, and it is thence led to a trough, where the folded sheets are collected.

Fig. 793.



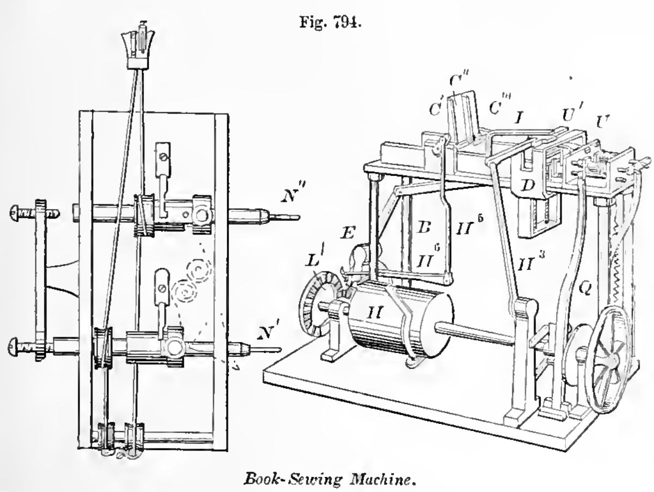
Chambers's Book-Folder.

Book-hold′er. A reading-desk top, or equivalent device, for holding an open book in reading position.

Book′ing. (*Agriculture.*) The arrangement of tobacco-leaves in symmetrical piles, the stems in one direction, *leaf* upon *leaf*, forming a *book*.

Book-sew′ing Ma-chine′. The feeder is composed of two plates *C′ C″*, inclined each toward the other, and almost touching at their outer ends. When the feeder is in the position shown in the figure, a folded "signature" is placed over it, the feeder is brought to a horizontal position, and then a horizontal plate moves forward between the plates of the feeder, and carries the signature to the points of the hooked needles *N′ N″*, which are then driven through the saw-kerfs in the back of the signature, and in this position a thread-carrier lays its thread in the hooks of the needles, and when the needles are carried back, they draw a loop of such thread through the back of the signature. When the needles pass into another signature, they draw the thread then laid within their hooks through the loops last formed

Fig. 794.



Book-Sewing Machine.

and yet on their shanks, and so enchain the thread along the backs of and secure the signatures together. The feeder vibrates alternately from a vertical to a horizontal position; in the former receiving the signature which straddles it, and in the latter forming guides for the horizontal plate which pushes the signature of the feeder up to the place where it is sewn.

Book-mus′lin. (*Fabric.*) A fine, transparent goods, like a Swiss muslin. It comes folded in *book* form. See BUKE-MUSLIN.

Book-per-fect′ing Press. (*Printing.*) One which prints both sides of a sheet without intermediate manipulation. Some act upon the respective sides in immediate succession, others have automatic feed between impressions. Such are the *Ford*, *Bullock*, *Walter*, and other printing-presses of the highest character and efficiency.

Bool-work. See BUHL-WORK. See also REISNER-WORK.

Boom. 1. (*Nautical.*) *a.* A spar for extending the foot of a *fore-and-aft* sail.

The boom on which a fore-and-aft sail is stretched is commonly provided with jaws which partially encircle the mast, and are held to it by a half-grommet strung with balls of hard wood to avoid friction.

b. A spar rigged out from a yard to extend the foot of a *studding-sail*. The *fore* and *main lower* yards, and the *fore* and *main topsail* yards have *studding-sail booms*. Each is secured by *boom-irons* on its yard, and is named from the studding-sail whose foot it stretches.

The heads of the studding-sails are bent to studding-sail yards which are slung from the studding-sail booms and the fore and main top-gallant yard-arms. The stays of these booms are called *guys*.

The *ring-tail boom* is rigged out like a studding-sail boom at the end of the *spanker*-boom.

c. The *booms;* the space on the spar-deck between the fore and main masts, where the boats and spare spars are stowed.

2. (*Marine Fortification.*) A chain or line of connected spars stretched across a river or channel to obstruct navigation, or detain a vessel under the fire of a fort.

3. (*Lumbering.*) A spar or line of floating timbers stretched across a river, or inclosing an area of water, to keep saw-logs from floating down the stream.

Boom′e-rang. A missile formed of a bent stick with a rounded and a flat side, and used by the Australian natives.

Among the various throwing-sticks of savage nations, this weapon of the Australians has caused most curiosity, from the apparently erratic character of its flight. It is a curved stick, round on one side and flat on the other, about 3 feet long, 2 inches wide, and ¾ inch thick. It is grasped at one end and thrown sickle-wise, either upward into the air, or downward so as to strike the ground at some distance from the thrower. In the first case it flies with a rotatory motion, as its shape would indicate, and after ascending to a great hight in the air, it suddenly returns in an elliptical orbit to a spot near its starting-point. On throwing it downward to the ground, it rebounds in a straight line, pursuing a ricochet motion until it strikes the object at which it is thrown.

The most singular curve described by it is when it is projected upward at an angle about 45°, when its flight is always backward, and the native who throws it stands with his back to the object he intends to hit.

The ancient Egyptians used curved throwing-sticks; but their shape was not like the one above described, nor their flight anything very peculiar.

The Esquimaux and some Brazilian tribes use throwing-sticks. The Purupurus have the *palheta*, a missile of a similar kind.

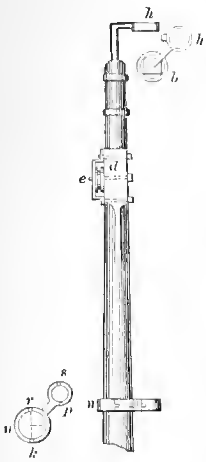
The *trombash* is a throwing-stick used by some of the interior tribes of Africa.

Another form of missile is the *bolas* of the Patagonians. See BOLAS.

The boomerang of the Moqui Indians, of Sonora, is a flat pointed stick, with a small ornament like an acorn at the handle end.

Boom-i'ron. (*Nautical.*) A flat iron ring on the yard, through which the studding-sail boom travels when being rigged out or in.

Fig. 795.



Boom-Iron.

One boom-iron, called the *yard-arm iron* (*b h*), is fixed at the end of the yard, and another iron, called the *quarter-iron* (*n*), is placed at $\frac{3}{16}$ of the length of the yard from the outer end.

The quarter-iron has a clasp *r k n*, which embraces the yard, and a clasp *s p*, which holds the heel of the studding-sail boom. *d* is the stop of the yard, and to it is secured the *check-block* *e* for the *sheets*.

Boom-jig'ger. (*Nautical.*) A tackle for rigging out or running in a topmast studding-sail boom.

Boom'kin. (*Nautical.*) A projecting spar at the bow of a ship, for hauling out the weather-tack in sailing near the wind. *Bumkin.*

A *fore-boom*, or bentick-boom, is sometimes used for spreading the foot of the fore-sail.

Booms. (*Nautical.*) A space amidships on the spar-deck, between the fore and main masts, where the launch or other large boat and spars are stowed.

Boon. The internal woody portion or pith of flax, which is disorganized by *retting*, the binding mucilage being softened by fermentation. The *boon* is partially removed in *grassing*, and together with the *shives* is completely eliminated from the *harl* or fiber in the subsequent operations of *braking* and *scutching*.

Boot. 1. (*Leather.*) A covering for the foot and lower part of the leg, made ordinarily of leather.

The various parts are designated in the illustration.

In the elevation *A* (Fig. 796), —

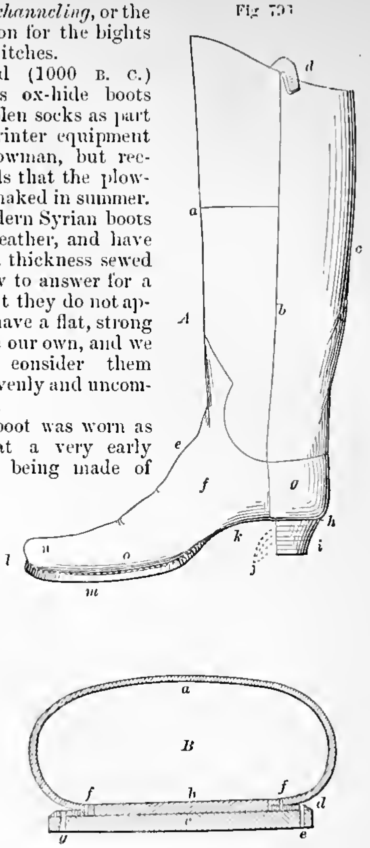
a is the *front.*
b the *side-seam.*
c the *back.*
d the *strap.*
e the *instep.*
f the *vamp* or *front.*
g the *quarter* or *counter.*
h the *rand.*
i the heel; the front is the *breast*, the bottom the *face.*
j the *lifts* of the heel.
k the *shank.*
l the *welt.*
m the *sole.*
n the *toe.*
o the *ball* of the sole.

In *B*, (same figure), —

a is the *upper.*
b the *insole.*
c the *outsole.*
d the *welt.*
e the *stitching* of the *sole* to the *welt.*
f the stitching of the *upper* to the *welt.*

g the *channeling*, or the depression for the bights of the stitches.

Fig. 796.



Boot.

Hesiod (1000 B. C.) mentions ox-hide boots and woolen socks as part of the winter equipment of a plowman, but recommends that the plowman go naked in summer. The modern Syrian boots are of leather, and have an extra thickness sewed on below to answer for a sole; but they do not appear to have a flat, strong sole like our own, and we should consider them very slovenly and uncomfortable.

The boot was worn as armor at a very early period; being made of leather with plates or greaves of metal to guard the front.

Moses says of Asher, "Thy shoes shall be iron and brass." 1451 B. C.

Homer, in his "Iliad," speaks of the brazen-booted Greeks.

In the Abbott Collection, New York, may be seen ancient Egyptian boots and shoes, of purple and red leather, and of white kid. Sandals were the common wear, and were made of leather, raw-hide, date-leaves, and papyrus. In the same collection is the mummied foot of a lady with the white kid gaiter boot yet remaining upon it. The foot is small and finely arched, resembling the true Arabian type. The boot is so fragile that it will not bear handling. The upper appears to be sewed to a sole, but does not show any heel. It is from Sakkarah.

The Median and Roman boots were laced up in front. See *Cothurnus*, in Smith's "Dictionary of Greek and Roman Antiquities."

The boot was called *ocrea* by the Romans. The *calceus* was a *shoe*, and the *solea* a *sandal*. The shoes of the Roman senators came up to the middle of the leg, and were generally *black*. On ceremonial occasions the Roman magistrates wore *red* shoes. Red and purple were regal, and red is yet a cardinal color.

The Etruscan augurs wore jack-boots.

The Lamas of Tartary wear red boots and yellow cloaks. They leave their boots in the vestibules of the temples. So do the Turks. The latter brought the practice from Central Asia.

"There bought a pair of boots; cost me 30 *s.*" — PEPYS, 1662.

The boot and shoe making business, more particularly since the introduction of pegs, which are said to have been invented by Joseph Walker, of Hopkinton, Mass., about the year 1818, has become a very extensive and important branch of manufacture, machinery being employed in nearly all the operations connected with the business. The first application of machinery in shoemaking is due to the celebrated Brunel, who devised a series of machines, which were operated by invalid soldiers belonging to Chelsea Hospital. The shoe passed through a number of hands before being finished; the operation which each man had to perform was so simple that it is said that the manipulation could be learned in half an hour. The sole was secured to the upper by nails. These machines, being employed solely for the manufacture of army shoes, appear to have fallen into disuse at the close of the war, and were never introduced into private establishments, the style of work probably not being suited to the demands of the public.

A long-legged boot made in Worcester, Mass., for the Pennsylvania coal-mines, is the most durable piece of furniture ever constructed of leather and iron. The soles are about three quarters of an inch thick, projecting like the guards of a Mississippi steamer. The heel also projects nearly a quarter of an inch, forming quite a shell near the counter, and flared at the bottom. Nails with a flat top, a size smaller than a three-cent piece, are driven as closely as they can be set all over the sole, shank, and heel, forming as it were a solid iron bottom. The boots weigh 6½ pounds, the nails contributing 1½ pounds to the weight. Long nails of Swedish iron are driven through the heel and shank, clinching on the inner sole; three to the heel and six to the shank. The sides are closed by hand with a six-stranded thread that will hold 100 pounds weight.

2. (*Carriage.*) The receptacle for baggage, etc., at either end of a coach.

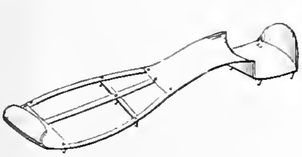
3. (*Menage.*) Protection for the feet of horses, enveloping the foot and a part of the leg. A convenient substitute for swaddling or bandaging. Patented in England by Rotch, 1810.

They are used on the feet of horses while standing in a stable, to keep the feet moist and prevent cracking or contraction of the hoofs. They may be lined with sponge, which is kept damp. The boot has an upper and sole, and is shaped to the foot nearly. The upper part has a draw-string.

They are also used for various affections of the legs and feet, such as varicose veins, splint, speedy-cut, strain. In such cases they are made to fit more closely.

Boot-calk. A spur for the boot-sole to prevent the wearer from slipping on ice.

Fig. 797.



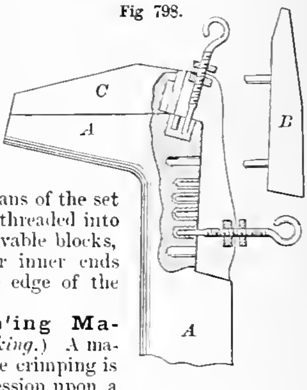
Boot-Calk.

Boot-chan'nel-ing Ma-chine'. One for making the slit in a sole to sink the sewing-thread below the surface. It consists of a jack on which the boot is held, an inclined knife gaged to depth, and a guide which causes the knife to make its incision at an equal distance from the sole-edge all round.

Boot-clamp. A device for holding a boot while being sewed. It consists of a pair of jaws, between whose edge the leather is gripped, and which are locked together by a cam, or by a cord which leads to a treadle.

Boot-crimp. (*Boot-making.*) A tool or a machine for giving the shape to the pieces of leather designed for boot uppers. Formerly the leather made a series of folds or crimps over the instep, and hence may have originated the name. The leather for uppers is now crimped by softening, straining over a former, and rubbing down the parts where the leather is thickened by the operation; that is, the parts which would be *crimped* or rugged, were the material not compacted at that point.

Fig 798.



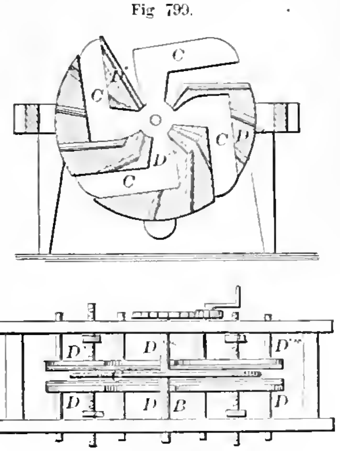
Boot-Crimp.

In the illustration, the edges of the leather are tacked over the pieces *C B*, which are then extended outwardly from the block *A* by means of the set screws, which are threaded into sockets in the movable blocks, and bear by their inner ends in pockets on the edge of the block *A*.

Boot-crimp'ing Ma-chine'. (*Boot-making.*) A machine in which the crimping is performed in succession upon a number of leather pieces cut to a pattern.

The boot-trees *C* are attached to a central shaft, which carries them around in contact with the adjustable ribs *D D*, which are so bent as to crimp the leather upon the trees.

Fig 799.

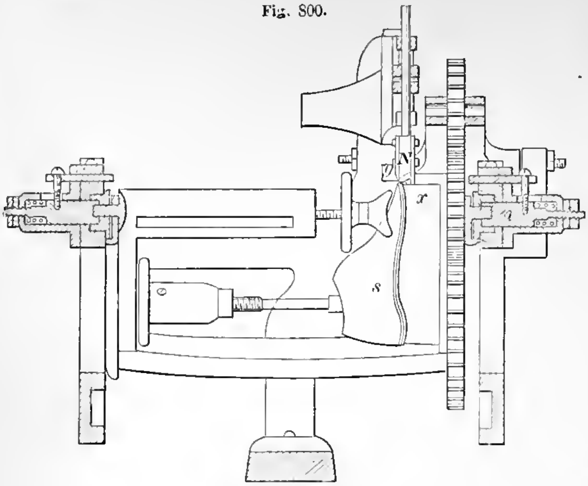


Boot-Crimping Machine.

Boot-edge Trim'mer. A machine which acts in connection with a guide to pare smoothly the edges of boot-soles. It is a machine-substitute for the edge-plane.

In the machine (Fig. 800), vertical, endwise, and rotary movements are imparted to the jack in which the shoe *s* is clamped. The gage *y* runs between the sole and upper leather of the shoe, and prevents the paring-knife from cutting into the upper leather. The cutter-head *N* rests upon the pe-

Fig. 800.



Boot-Edge Trimming Machine.

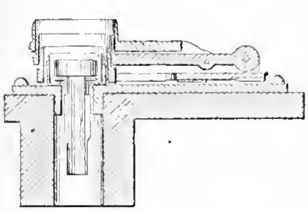
riphery of the pattern *x*, which governs the depth of cut.

Boot'ee. (*Fabric.*) A white, spotted Dacca muslin.

Boot-groov'ing Ma-chine'. One for making the groove in a shoe-sole to sink the sewing-threads below the surface. A *channeling-machine.*

Boot-heel Cut'ter. A machine for cutting the lifts for making boot-heels. In the example the cutters are various in size, and are hinged to the frame, so that they can be let down over each other. The heel-lifts are cut to graduated size, and merely require beveling after attachment. The leather is placed on the cutters, and forced down by blows of a wooden mallet.

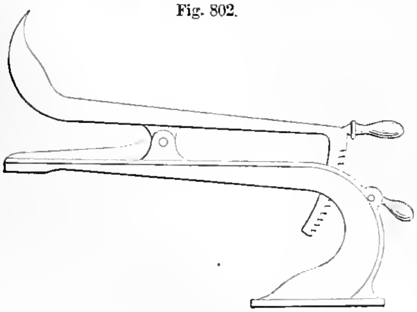
Fig. 801.



Boot-Heel Cutter.

Boot-hold'er. A jack for holding a boot either in the process of manufacture or for cleaning. The base-piece is attached to a bench, and has a stationary prong. The movable prong, containing the foot-piece, is attached to the other, and is held at its adjustment by a curved rack and pawl.

Fig. 802.



Boot-Holder.

Boot-hook. A device for drawing on boots and shoes, consisting essentially of a stout wire bent into a hooked form and provided with a handle.

Boot-jack. A board with a crotch to retain the heel of a boot while it is being pulled off.

Boot-jacks are made jointed, so as to fold into compact form. Recesses are made in them to hold a small brush and a minute box of blacking. Cases are made to contain all three, being nattily arranged to suit the fastidious.

A boot-rack is merely a frame to hold boots, and would not be here cited but that several patents have been granted for special contrivances in that line.

Boot-mak'ing Ma-chine'. Screws have been employed in France since 1844 for securing soles to shoes.

Machines for making boots are adapted for specific parts of the operation; such as *heel-machines,* which include *cutters, randing, heel-cutting, heel-trimming,* and *heel-burnishing* machines.

Upper-machines; which include *crimping, turning, seam-rolling,* and *trimming* machines.

Sole-machines; which include *cutting, channeling, burnishing,* and *pegging* machines.

Lasting-machines; for drawing the upper portion of the boot firmly on to the last.

Pegging-machines; pegging-jacks for holding boots while being pegged.

Crimping-machines; for stretching and pressing into shape leather for uppers.

Besides these there are numerous hand-tools, such as *burnishers, edge-planes,* and *shaves, pegging-awls,* etc. See list under LEATHER.

In one arrangement of screw-wire boot-making machinery is the following series: —

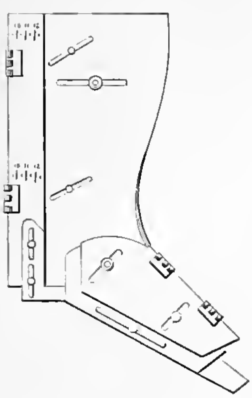
The leather is cut into shape by means of tools resembling punches. The thicknesses which are to form the soles are united with glue, and compressed previously to being cut. They receive then the necessary concavity by powerful hydraulic pressure, and their surfaces are smoothed and hardened in still another machine. Sewing-machines form all the necessary seams, binding, and, if necessary, ornamental stitching of the upper leathers; and then the separate parts are brought together in the machine which is to complete the shoe by uniting the upper leather and the sole.

First there is placed upon the form or last in this machine the inner sole. The upper leather is then stretched over this by means of small nippers attached to the machine, which are capable of stretching it with considerable force. It is secured in place by a row of small nails. The outer sole is then carefully applied over the whole. As this has been entirely finished and polished on the edges in the previous process of preparation, it is important that it be truly adjusted, since it cannot be afterwards trimmed. The machine then applies to the two soles, with the upper leather included between them, a force of pressure of not less than 700 pounds, increased, if desired, to one ton. Screws are then inserted all round the margin of the sole, an operation completed in less than three minutes for a single shoe, or in five minutes for a pair. The salient extremities of the screws are cut by a chisel, and the burr left by the chisel is ground away on an emery-wheel. The last on which the shoe is constructed, being made of iron, prevents the interior extremities from passing the surface of the inner sole.

The machines not only apply, but make the screw. The material is brass, which is drawn off from a bobbin in the machine as it is required. The extremity passes horizontally through a guide, and, in order to cut the thread of the screw, the whole bobbin revolves. In hand-machines a crank serves to give the revolution; but the driving power may be taken from a motor. When the resistance shows that the screw has struck the iron last, a cutter is brought into action by the foot of the operator pressing upon a pedal, and the wire is cut as near as possible to the leather.

Boot-pat'tern. A templet made up of plates which have an adjustment on one another, so as to be expanded or contracted to any given dimensions within the usual limits of boot sizes. Used in marking out shapes and sizes on leather ready for the cutter.

Fig. 803.

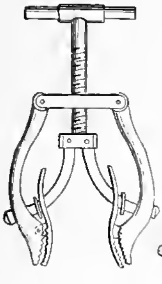


Boot-Pattern.

Boot-seam Rub'ber. A burnishing-tool for flattening down the seam where the thicknesses of leather are sewed together. This is usually a hand-tool, but sometimes is a machine in which a boot-leg, for instance, is held on a jack while the rubber, either a roller or a burnisher, is reciprocated upon the seam.

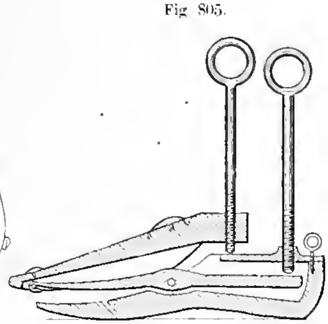
Boot-shank Ma-chine'. A tool for drawing the leather of the upper or boot-leg over the last into the hollow of the shank. In the example, the leather, being placed over the last, is inserted between the jaws which are pivoted to the plate. The screw connecting with the jaws by arms is then turned, and causes the jaws to be brought together, thus stretching the leather.

Fig. 804.



Boot-Shank Machine.

Fig. 805.



Boot-Stretcher.

Boot-stretch'er. (*Leather.*) A device for stretching the uppers of boots and shoes. The common form is a two-part last, divided horizontally and having a wedge or a wedge and screw to expand them after insertion in the boot.

In the example the last is divided into an upper and under section which are connected by a lever. The fore end of the upper section is pivoted to the fore end of the lever, and the middle end of the lever is fulcrumed at the mid-length of the lower section. The screws operate to raise the rear end of the upper section immediately, and its fore end through the medium of the lever. The upper surface of the last has changeable knobs to stretch the leather in particular places.

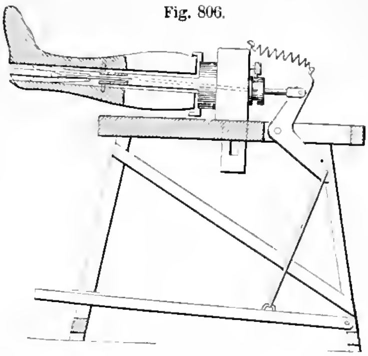
There are many kinds for special uses.

22

Boot-top'ping. (*Nautical.*) The operation of scraping off grass, barnacles, etc., from a vessel's bottom, and coating it with a mixture of tallow, sulphur, and rosin.

Boot-tree. An instrument composed of two wooden blocks, constituting a front and a rear portion, which together form the shape of the leg and foot, and which are driven apart by a wedge introduced between them to stretch the boot. The foot-piece is sometimes detachable. In the illustration the tree is shown mounted on a trestle, the center wedge being driven by the motion of a treadle.

Fig. 806.



Boot-Tree.

Boot-ven'ti-la'tor. A device in a boot or shoe for allowing air to pass outwardly from the boot so as to air the foot. It usually consists of a perforated interior thickness, a space between this and the outer portion, and a discharge for the air, through some part of the said outer portion above the water-line.

Bo'quin. (*Fabric.*) A coarse Spanish baize.

Bord. (*Mining.*) A lateral passage where a shaft intersects a seam of coal.

Bor'der. 1. (*Milling.*) The *hoop*, *rim*, or *curb* around a bedstone or bedplate, to keep the meal from falling off except at the prescribed gap. Used in gunpowder mills and some forms of grain-grinding mills.

2. (*Printing.*) *a.* A type with an ornamental face, suitable for forming a part of a fancy border.

b. Ornamental work surrounding the text of a page.

3. (*Locksmithing.*) The rim of a lock.

4. (*Fabric.*) That part of cloth containing the selvage.

Bor'der-pile. (*Hydraulic Engineering.*) An exterior pile of a coffer-dam, etc.

Bor'der-plane. A joiner's edging-plane.

Bor'ders. (*Fabric.*) A class of narrow textile fabrics designed for edgings and bindings; such as galloons and laces.

Bor'der-stone. The curbstone of a well or pavement.

Bore. 1. (*Metal-working.*) A tool *bored* to fit the shank of a forged nail, and adapted to hold it while the head is brought to shape by the hammer. The depression in the face of the *bore* is adapted to the shape required of the chamfered under part of the head.

2. The cavity of a steam-engine cylinder, pump-barrel, pipe, cannon, barrel of a fire-arm, etc. In mechanics it is expressed in inches of diameter; in cannon in the weight in pounds of solid round shot adapted thereto, as 8 dr., 12 dr., or in inches of diameter, as, 8-inch gun, 12-inch gun; in small-arms, in hundredths of an inch decimally, thus, .44, .55, in this case it is termed *caliber*; in sporting rifles by the number of balls to the pound; in smooth-bore fowling-pieces by a trade number, as No. 9, 10, 11, etc.

2. The caliber of a wind-instrument; as, the *bore* of a flute.

3. The capacity of a boring-tool; as, the *bore* of an auger.

Bor′el. (*Fabric.*) *a.* Formerly, a coarse woolen cloth.

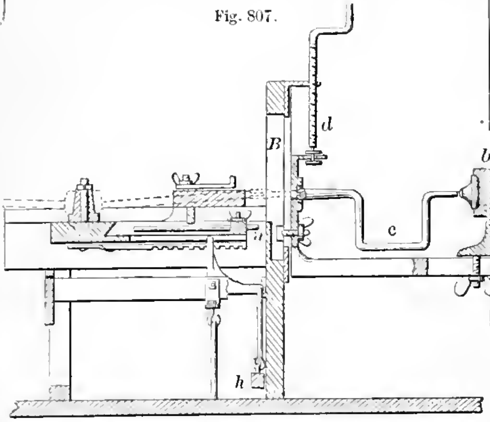
b. A light stuff with a silken warp and woolen woof.

Bor′er. (*Coopering.*) A semi-conical tool used to enlarge bung-holes and give them a flare.

Bo-ril′la. (*Metallurgy.*) A rich copper ore in dust.

Bor′ing and Ten′on-ing Ma-chine′. (*Wheelwrighting.*) One adapted to bore the holes in the fellies and to cut the tenons on the ends of the spokes. In the example, the wheel is mounted on sliding-bed

Fig. 807.



Boring and Tenoning Machine.

D, and pressure on the treadle *h* draws the spoke to the hollow auger, whose stock is turned by hand till arrested by the stop *n*. For boring fellies a detachable bed is fitted on the sliding carriage. A screw-clamp in the bed holds the felly, which is moved up to the auger, turned by hand as in the former case, and arrested by a gage-stop. The brace c is mounted between the back-plate *b* and a socket in the standard *B*.

Bor′ing-bar. (*Metal-working.*) A bar supported axially in the bore of a piece of ordnance or cylinder, and carrying the cutting-tool, which has a traversing motion, and turns off the inside as the gun or cylinder rotates.

Also, a cutter-stock used in other boring-machines, such as those for boring the brasses of pillow-blocks.

Bor′ing-bench. (*Wood-working.*) A bench fitted for the use of boring machinery or appliances. BENCH-DRILL.

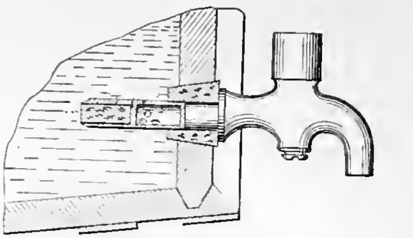
Bor′ing-bit. A tool adapted to be used in a brace. It has various forms, enumerated under the head of BIT (which see).

Bor′ing-block. (*Metal-working.*) A slotted block on which work to be bored is placed.

Bor′ing-col′lar. A back-plate provided with a number of tapering holes, either of which may be brought in line with a piece to be bored and which is chucked to the lathe-mandrel. The end of the piece is exposed at the hole to a boring-tool which is held against it.

Bor′ing-faucet. One which has a bit on its end by which it may cut its own way through the head of a cask. In casks whose holes are already plugged with cork the inner edge of the stem of the tap is made hollow to receive the cylinder of cork, and with an annular cutting-edge. A stop is placed in

Fig. 808.

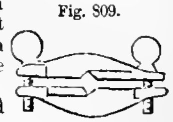


Boring-Faucet.

the stem to prevent the cork cylinder from reaching and closing the holes in the stem.

Bor′ing-gage. A clamp to be attached to an auger or a bit-shank at a given distance from the point, to limit the penetration of the tool when it has reached the determinate depth.

Fig. 809.



Boring-Gage.

Bor′ing-lathe. A lathe used for boring wheels or short cylinders. The wheel or cylinder is fixed on a large chuck screwed to the mandrel of a lathe.

Bor′ing-ma-chine′. The term may be held to have a somewhat general application to all machines by which holes are made by the revolution of the tool or of the object around the tool, but not including the simple tool itself. Thus an auger, gimlet, awl, or any *bit* adapted for boring, independently of the machinery for driving it, would not be a boring-machine. A *brace* is on the dividing line, if such there be, but is not included under the term *boring-machines*.

Borers for metal, however, are usually classed as drills, and in the present classification the bits and tools for metal will be classed as *drills*, the means for driving them as *drilling-machines*, excepting the largest class, which *bore out* large cylinders, ordnance, etc. We get back again to the term *boring* at this point, despite our attempts to preserve the unity of classification. These machines have usually a *boring-bar* or *cutter-bar*, which occupies the axis of the object which is being bored, and as three parts are involved and two motions required, several possible transpositions might be anticipated and various trinary combinations actually exist.

1. The parallel shaft of the boring-bar slides accurately in a groove exactly parallel with the bore; the cutting-blade is a small piece of steel affixed to the end of the half-round block, and the cut is advanced by a rack and pinion movement, actuated either by the descent of a constant weight or by an automatic motion derived from the prime mover. This is used in boring ordnance.

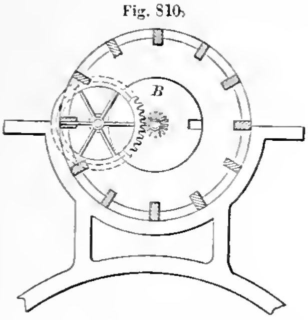
2. The cutter-bar revolves without longitudinal motion on fixed centers, like a spindle in a lathe; the work is traversed longitudinally past the rotating cutter, being supported on a slide-rest. This mode requires that the cutter should measure between the supports twice the length of the work to be bored, and the cutter to be at the midlength of the bar.

3. The cutter-bar revolves and also slides with an endwise motion, the work being at rest: the bearings of the bar are frequently attached to some temporary support in the work to be bored, as, for instance, a cast-iron cross at each end of the cylinder. The crosses are bored exactly to fit the boring-bar, one of them carries the driving-gear, and the bar is thrust endwise by means of a screw moved by a ratchet-wheel.

In another arrangement the boring-bar is mounted in head-stocks, much the same as a traversing mandrel; the work is fixed to the bearers carrying the head-stocks, and the cutter is advanced by a screw. The screw is then moved by a ratchet-wheel, or by the hand of the workman, one tooth in each revolution; or else by a system of differential wheels, in which the external screw has a wheel, say, of 50 teeth, the internal screw a wheel of 51 teeth, and a pair of equal pinions drives these two screws continually, so that an advance of $\frac{1}{50}$ of a turn of their screw, or their difference, is equally divided over one revolution of the cutter-bar, as in the feed-motion of the hand-drilling machine with the differential feed. This method only requires the fixed bearings of the cutter-bar to be as much longer than the work as the length of the cutter-block, but the bar itself must be more than twice the length of the work, and slides through the supports.

4. The boring-bar revolves upon fixed bearings without traversing, and it is only needful that the boring-bar should exceed the length of the work by the thickness of the cutter-block, of which it has commonly several of different diameters. The cutter-block, now sometimes 10 feet in diameter, traverses as a slide on a spline down a huge boring-bar *B*, whose diameter is about 30 inches. The motion of the cutter-block is caused by a side-screw, upon the end of which is a large wheel that engages in a small pinion *fixed* to the stationary center or pedestal of the machine. With every revolution of the cutter-bar, the great wheel is carried around the fixed pinion, and, supposing these to be as 10 to 1, the great wheel is moved $\frac{1}{10}$ of a turn, and imparts an equiva-

Fig. 810.



Cylinder Borer.

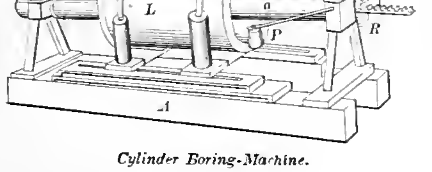
lent motion to the feed-screw that moves the cutter-block.

This machine was invented by George Wright when in the employment of Boulton and Watt, Birmingham, England.

A machine substantially the same, but with a different feed arrangement, is shown in the accompanying illustration.

The boring-machine (Figs. 811 and 812) has a

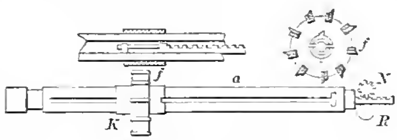
Fig. 811.



Cylinder Boring-Machine.

cutter-head revolving with and sliding on a mandrel *a*, which is in the axis of the cylinder. The cylinder *L* is secured to the bed *A* of the machine in exact conformity to the axial position of the mandrel *a*. The mandrel is a hollow iron tube with two opposite longitudinal slots, through which the action of the advancing apparatus is communicated to the cutter-head *f*, which is sleeved upon the mandrel *a*. The cutter-head consists of two parts: a

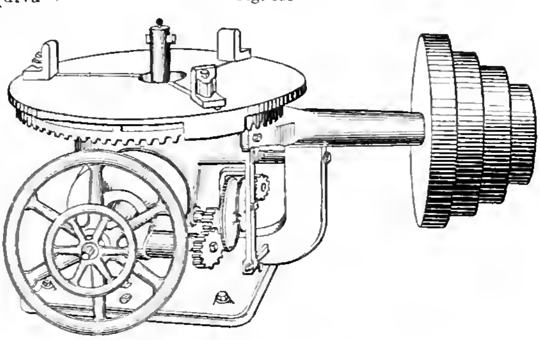
Fig. 812.



Mandrel and Cutter.

sleeve *K*, which fits upon the mandrel, and a head *f*, which is secured upon the sleeve by wedges, and has cutters inserted into notches in its periphery. The sleeve *K* slips longitudinally on the mandrel *a*, but is restrained from revolving on it by two transverse bars, which act as a spline, and also connect the sleeve with a rack-bar inside, by which its longitudinal motion is effected. The rack-bar rests upon a roller *R*, and is moved by a pinion *N*, to which is connected a lever-arm having a weight *P* on its end. The cutters having been proved to revolve truly, the cutter-head is advanced, and is kept

Fig. 813



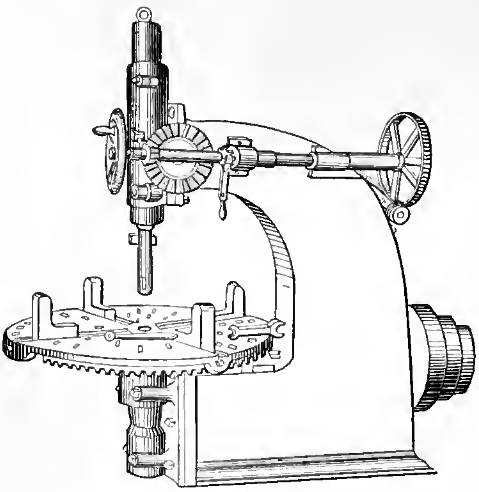
Sellers's Boring-Mill.

pressed against its work by the weight of the lever, which exerts a constant strain upon the rack. As soon as the lever has descended, it is again raised by hand, and this is the only attention necessary.

5. The work is dogged to a rotating-table, and the cutter is advanced as in Sellers's boring-mill (Fig. 812). This is a heavy boring-machine for car-wheels and general work, fitted with universal chuck for all sizes up to 36 inches diameter, and capable of boring driving-wheels 6 feet in diameter; the cross-head for holding the boring-bar is counterbalanced and arranged with power-feed and quick hand-traverse in either direction; the sliding surfaces are kept clear of chips which fall through the face-plate as in mills where the bar is supported above, as in Fig. 814.

A vertical boring-machine, expressly adapted for boring car-wheels, yet also available for many kinds of miscellaneous boring. It is so made as to be readily adjusted for taper or parallel holes, has rack and pinion feed with counterbalanced bar. For holding wheels or other work, a chuck is fitted to the bed, which retains the work in place while

Fig. 814.

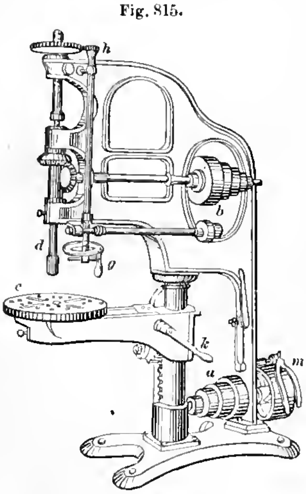


Boring-Machine.

being operated upon by means of jaws of the proper shape, and moving independently of each other. These jaws are made of wrought-iron case-hardened. The swing of the machine is four feet.

Fig. 815 shows a boring-machine of medium size, having a horizontal face-plate *c* on which the work is dogged. *a b* are the nests of pulleys by which graduated speed is given to the boring-shaft *d*. The latter is advanced to its work or retracted by means of the hand-wheel *g*, or the automatic feed-arrangement *h* may be thrown into gear. *k* is the handle acting upon a pinion and rack, to raise or lower the table *c*. *m* is the belt-shifter.

Fig. 815.

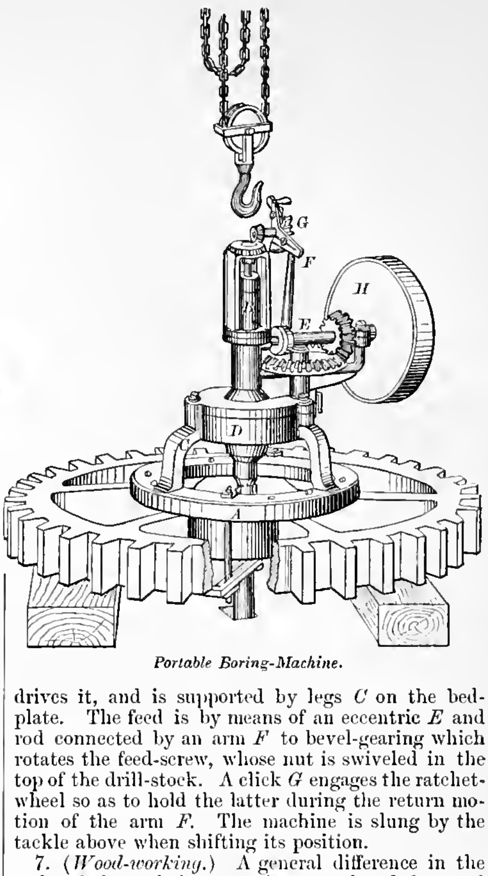


Boring-Machine.

Another form of boring-machine, by which the turret of a "Monitor" may be bored within and turned off without, is described under LATHE. Its bed is a face-plate on a vertical axis. The tools are held in a cross-slide, which is fitted to two uprights, resting on cheek-pieces bolted to the main casting or foundation-piece.

6. The borer is portable, and is dogged to the work. The *portable boring-machine* (Fig. 816) is adapted to set vertically upon the work in cases where it is easier to bolt the machine to the work than to dog the work in the machine. The base-plate *A* of the drill is bolted to the face of the wheel in the example given, and is rotated by bevel-gearing from the axle of the band-wheel *H*. The box *D* holds the wheel on the drill-stock *B*, and the pinion which

Fig. 816



Portable Boring-Machine.

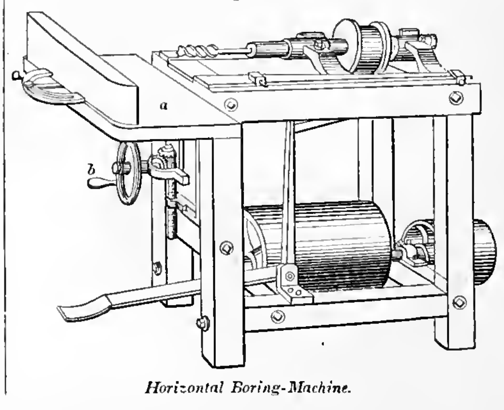
drives it, and is supported by legs *C* on the bed-plate. The feed is by means of an eccentric *E* and rod connected by an arm *F* to bevel-gearing which rotates the feed-screw, whose nut is swiveled in the top of the drill-stock. A click *G* engages the ratchet-wheel so as to hold the latter during the return motion of the arm *F*. The machine is slung by the tackle above when shifting its position.

7. (*Wood-working.*) A general difference in the style of the tools between those employed for wood and those for metal gives opportunity for distinguishing between the two classes of machines, although it must be admitted that the modes of propulsion in some machines of the respective classes are very similar, and that the boring *bits* for hard wood are much like the *drills* for metal.

The one are described as *augers* and *bits*; the other as *drills*.

Fig. 817 represents a horizontal boring-machine

Fig. 817.

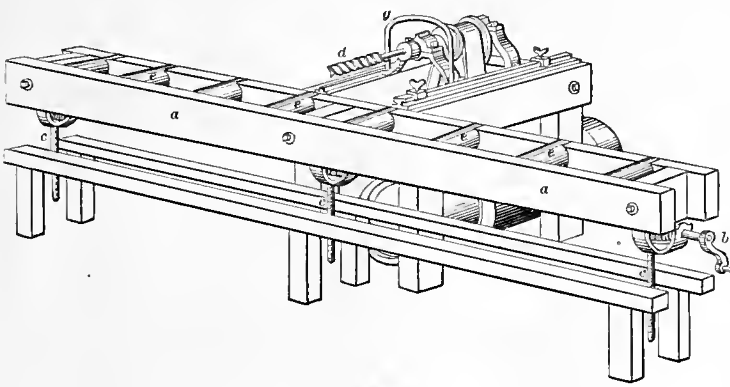


Horizontal Boring-Machine.

for carpenter's and machine shops, for pattern-makers, carriage, piano-forte, and all cabinet work, etc. The boring-shaft runs in stationary boxes; the table *a*, with stuff, slides up to the bit, and is raised and lowered by a screw and hand-wheel *b*, as desired. The boring and counter-shafts have cone-pulleys for a change of speed. These machines are arranged for augers with round or square shanks.

The machine Fig. 818 is very generally used for car work, and does a variety of boring without the

Fig. 818.

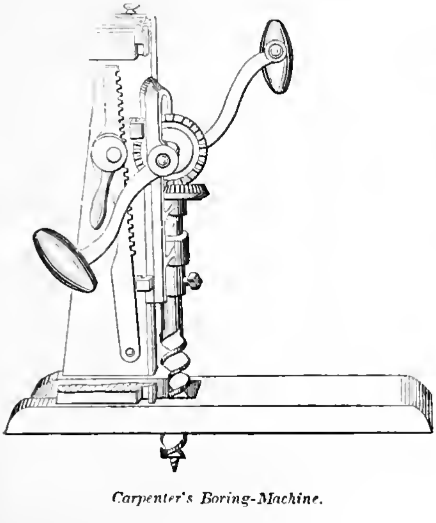


Boring-Machine.

trouble of setting out for the work. The carriage *a* is 12 feet long by 1 foot wide, is raised and lowered by a crank-shaft *b*, and screws *c c*, to bring the work to the right position with the bit *d*, and is held in place on the rear side of the frame. The bit is drawn up to the work by a bowed handle *g* on the front end of a boring shaft-slide. The timber laid upon the carriage is moved horizontally on iron rolls *e*, to finish the work. The counter-shaft has tight and loose pulleys.

8. The *carpenter's boring-machine* simplifies the business of making mortises by boring a hole perpendicularly (or at any required angle. The auger is rotated by the double-crank shaft and the intervention of bevel-gearing. The auger feeds it into the wood, but pressure can be brought thereon if necessary. The auger is raised vertically from the hole by throwing the rack at the side in gear with a wheel on the crank-shaft, and rotating the latter. The rack is thrown in and out by an eccentric; an arrangement patented by Stanley and Johnson, September 12, 1865.

Fig. 819.

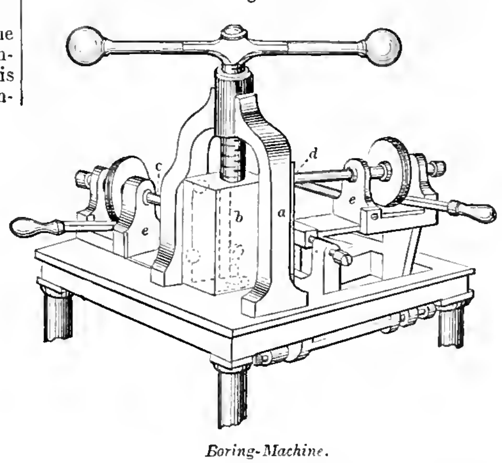


Carpenter's Boring-Machine.

Boring-machines of various kinds are in use in bedstead, furniture, and other manufactories. In some cases the bits or augers are arranged in gangs in a gate or slide, which is slipped forward towards the work, making a whole row of holes of a given depth. This is the plan in making the holes in the round bedstead-rails for the reception of the pegs which hold the ropes.

The *boring-machine* for block-making consists of an iron frame *a*, in which the *juggle b* is clamped by a screw, which confines it while the borers *c d* act upon it. These borers are center-bits, and act at right angles to each other, — *c* to form the hole for the sheave-pin, and *d* to form a commencement for the mortise to contain the sheave. Each bit is fixed in a lathe-head *e e*, and driven by a band. The head slides upon ways, so as to feed up to the work, being advanced by a lever. The ways have a certain lateral and vertical adjustability so as to work at the required angle and hight.

Fig. 820.



Boring-Machine.

Bor'ing-ta'ble. The platform of a boring-machine on which the work is laid.

Bor'ing-tool. (*Metal-working.*) A cutting-tool placed in a cutter-head to dress round holes.

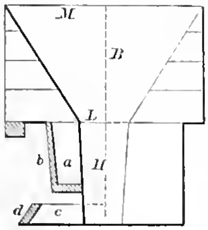
Bort. (*Diamond-cutting.*) Small fragments of diamond, split from diamonds in roughly reducing them to shape, and of a size too small for jewelry. Bort is reduced to dust in a mortar, and used for grinding and polishing.

Bo'shah. (*Fabric.*) A Turkish-made silk handkerchief.

Bosh'es. (*Metallurgy.*) The sloping sides of the lower part of a blast-furnace, which gradually contract from the belly, or widest part of the furnace, to the hearth.

In a furnace 55 feet high and 38 feet wide at the base of the structure, the boshes will be 8 feet in perpendicular hight, 12 feet wide at top (*M*), and $2\frac{1}{2}$ feet at the bottom (*L*), where they join the hearth. The boshes are built of a coarse-gritted freestone, abounding in small nodules of quartz.

Fig. 821.



Boshes.

The cut represents the *hearth H* and *boshes B* in a vertical side-section. *a* is the *tymp-stone* and *b* the *tymp-plate* for confining the molten metal in the hearth. This plate, in connection with the protecting stone *a*, forms the front of the hearth, and is firmly wedged into the side-walls thereof. *c* is the *dam-stone* which occupies the whole breadth at the bottom of the hearth, excepting about six inches, which space, when the furnace is at work, is filled before every cast with a strong binding sand. This stone is faced outside by a strong cast-iron plate *d*, called a *dam-plate*. The space under the *tymp-plate* is rammed full, for every cast, with strong, loamy earth or fine clay, — a process called *tymp-stopping*.

A number of newly invented puddling and boiling furnaces have iron floors and boshes. A current of water is caused to circulate in them to prevent destruction of the iron under the extreme heat.

Baker's *puddling-furnace* has a hollow cast-iron bed-plate and bosh, through which water is conducted.

Williams's *furnace* has hollow bridges with air-chambers and water-boshes.

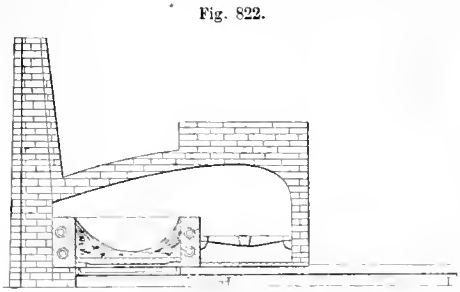
Hall's *furnace* has fire-brick around the iron bed against which jets of water are injected from tubes.

Snyder's *furnace* has a wrought-iron bed-plate with brick boshes.

Whipple's *furnace* has a double bottom of iron. The lower plate is corrugated. Water conducted into the hollow bed and boshes is converted into steam and conducted away.

In Fig. 822 the bosh is cast upon wrought-iron pipes which will afford circulation for water to cool and preserve the bosh. The water-chamber beneath

Fig. 822.



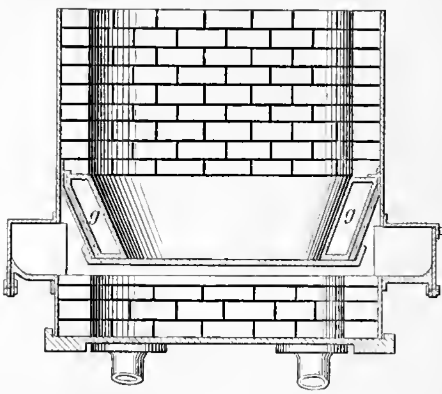
Puddling-Furnace

has the same effect. The front plate is attached by tongues and grooves to the bosh, and the fore-plate similarly attached in the front plates.

The material which is banked up against the boshes to protect them from the heat is called *fixing*. It consists of scrap and ore, and receives a preliminary melting. One *composition for fixing* furnaces consists of finely pulverized ore and German clay made into a paste; and another for the same purpose is a paste made by grinding the ore and rendering it plastic by moistening and working. *Bull-dog* (Fr. *trochi*) is a decomposed protosilicate of iron used in England and France for this purpose.

Grout's *cupola and blast-furnace*, instead of fire-brick lining to the hearth, has hollow cast-iron boshes united by flanges, forming chambers *g*, so arranged that a current of cold water may flow

Fig. 823.



Blast-Furnace Iron Boshes.

through them, dispensing with an internal lining of fire-brick or other refractory substance.

These chambers are so arranged that they may be removed without disturbing the superior brick-work.

Bo'som. (*Milling.*) A recess or shelving depression round the eye of a mill-stone.

Bo'som-fold'er. A plaiting machine or device for laying a fabric in flat folds, suitable for a shirt-bosom.

Boss. 1. (*Machinery.*) *a.* An elevated or thickened portion, usually around an aperture.

b. A swage or stump used in shaping sheet-metal.

2. (*Architecture.*) In Gothic architecture, the protuberance in a vaulted ceiling formed by the junction of the ends of several ribs, and serving to bind them together; usually elaborately carved and ornamented.

3. (*Masonry.*) *a.* A mortar-bucket slung by a hook from the round of a ladder.

b. A short trough for holding mortar. Hung from the laths and used in tiling a roof.

4. (*Saddlery.*) The enlargement at the junction of the *branch* of a bridle-bit with the mouthpiece.

5. (*Ordnance.*) A plate of cast-iron secured to the back of the hearth of a traveling-forge.

6. (*Bookbinding.*) A metallic ornament on a book side to receive the wear.

Bos'sage. (*Architecture.*) Projecting stones, such as quoins, corbels, roughed out before insertion, to be finished *in situ*.

Bos'sing. (*Porcelain.*) *Ground-laying* the surface of porcelain in an unfinished state, to form a basis of adherence for the color, which is deposited by the *pencil*, by *cotton-wool*, or by *stencil*, according to the mode. The *bossing* is a coat of boiled oil, to hold the color. The oil is expelled by the heat of the enamel-kiln, and the color vitrified.

The *bossing* is laid on with a hair-pencil, and leveled with a *boss* of soft leather.

Bott'ger-ware. The white porcelain of Dresden. Made originally by Bottger, of Saxony, in imitation of the Chinese. It is now made in the old castle, once the residence of the Saxon princes, at Meissen on the Elbe, 15 miles below Dresden.

Bott-ham'mer. (*Flax.*) A wooden mallet with a fluted face, used in breaking flax upon the floor to remove the *boon*.

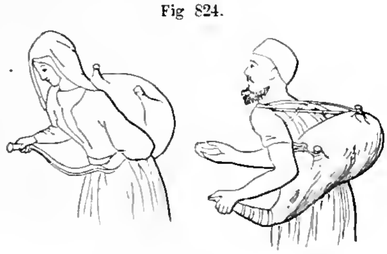
Bot'ting. (*Metallurgy.*) Restopping the *tapping-hole* of a furnace after a part of its charge has been allowed to flow therefrom. The plug is a conical mass of clay on the end of a wooden bar.

Bot'tle. A vessel with a relatively small neck, and adapted to hold liquids. In ancient times they were made of leather. The Psalmist declares he has "become like a bottle in the smoke," that is, shriveled and wrinkled. It is also advised by the Savior, — a metaphysical meaning being couched in the words, — not to put new wine into old bottles, as they could not withstand the action of fermentation.

The skin-bottles of the East are made of goat-skins; when the animal is butchered, its head and feet are cut off, and the skin drawn off without ripping. In Arabia it is tanned with acacia bark, the hair being left on the outside. The several openings are sewn up, and the neck, which serves as a spout, is tied. Such bottles were used by the Greeks, Egyptians, and Romans, being mentioned by Homer, Herodotus, and Virgil. They are also used to the present day in Spain and Sicily, and other Mediterranean countries; they are called *borrachas* in Spain, and the peculiar flavor of marsala and some other wines is attributed to the skins in which they were originally brought to market.

Bottles of earthenware are usually made with handles, and are called flasks. Cast-iron bottles, closed by a screw-plug, are used for holding quicksilver. Glass is, however, the material almost universally employed in the bottle manufacture. It is generally of the coarsest and commonest kind, made from inferior materials; in fact, the use of any others for the purpose was prohibited in England until a comparatively recent period. Six persons are employed in the necessary manipulations; one of whom

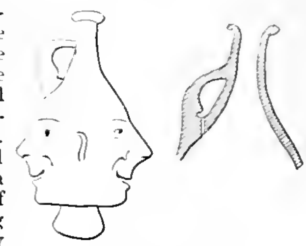
Fig 824.



Skin-Bottles.

dips the red-hot end of an iron tube into the pot of molten glass, turns the rod around so as to surround it with glass, lifts it out to cool a little, then dips and turns it around again, and so on until he has collected a ball of sufficient size to form the required bottle. He then hands it to the blower, who rolls the plastic lump of glass on a smooth stone or cast-iron plate until he brings it to the very end of the tube, forming a pear-shaped lump, when he introduces it into an open brass or cast-iron mold, which he shuts together by pressing a pedal with his foot, and, holding the tube vertically, blows through it, expanding the glass so as to fill the concavity of the mold. Upon removing his foot from the pedal the two halves of the mold open, turning upon a hinge at the bottom. The bottle is then removed and handed to the finisher, who, by touching the tubular neck of glass by which the bottle adheres to the pipe, cracks it off smoothly at the mouth; the finished bottles are then placed in the annealing-furnace and allowed to cool slowly for twenty-four hours or more.

Fig. 825.



Peruvian Bottle.

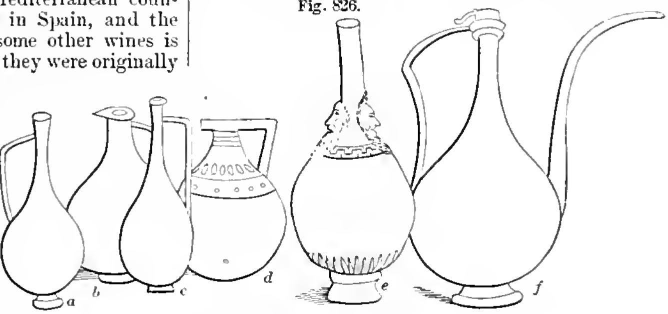
This kind of mold produces a seam down each side of the bottle, causing a rather unsightly appearance. See GLASS.

Glass bottles were known to the Romans of the Empire, and are found in Pompeii.

A glass bottle with a capacity of 112 gallons was blown at Leith, in Scotland, about 1747.

Fig. 825 shows an earthen bottle from Peru, with two faces. The sectional view shows the shape of the neck and handle.

Fig. 826.



Earthenware Bottles.

Fig. 826 shows a number of ancient bottles.

a b c are from Thebes.

d is Etruscan.

e is from China.

f from ancient Egypt.

Bot'tle-boot. A leather case to hold a bottle while corking.

Bot'tle-brush'ing Ma-chine'. A device for cleansing the interior of bottles. The brushes, fixed on a rotating shaft, are inserted into the bottles, and rotation imparted by means of the treadle *b*. The operator may take a bottle in each hand, cleansing two at once.

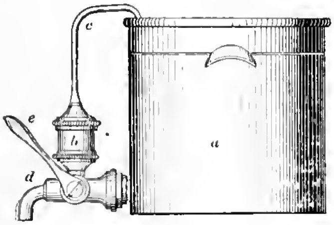
Fig. 827.

Bottle-Brushing Machine.

Bot′tle-case Loom. A machine in which the wicker cover is placed upon demijohns and carboys. This is, however, almost entirely done by hand, and is the work of a basket-maker.

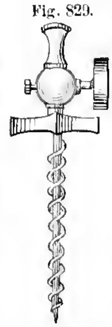
Bot′tle-charg′er. An apparatus for charging bottles with a liquid under pressure, as, for instance, with air containing carbonic acid, and with a graduated amount of syrup. *a* is the vessel containing the aërated water; *b* the syrup-cup; *c* a pipe equalizing the pressure in the vessels *a* and *b*. The size of the opening leading from the cup *b* to the common nozzle *d* is adjustable, and *e* is the handle of the faucet by which the liquid is discharged.

Fig. 828.



Bottle-Charger.

Fig. 829.



Bottle-Faucet.

Bot′tle-fau′cet. A faucet adapted to the uses of a bottle, as in the illustration, where it has a threaded hollow stem to transfix the cork.

Bot′tle-fill′er. See Bottling-apparatus.

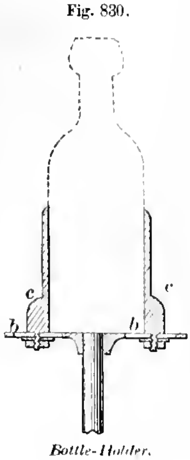
Bot′tle-glass. Bottle-glass is composed of cheap sand and alkali, and the manufacture has nothing special about it. Bottles were formerly made by blowing and rolling, but since the introduction of presses, blowing and molding have been combined. The mass of molten glass at the end of the tube (*pontil*) is inserted in an iron mold, which gives the external form, while the hollowness is produced by blowing through the tube.

The alkalies used are wood ashes and common salt. Common sand, gas lime, clay, and the refuse lime and alkali after the manufacture of soap, enter into the composition of *frit* for bottle-glass.

Beer and wine bottles are blown in a mold. Carboys are blown by the aid of steam, which is produced by spirting a mouthful of water through the blowing-tube, the end of the tube being covered by the thumb.

Bot′tle-hold′er. An adjustable tool for grasping the bottle by its base while finishing the top.

Fig. 830.



Bottle-Holder.

The disk *b* is attachable to the punty-rod, and slotted radially to receive the clamps *c c*, which are adjusted to various sizes of bottles; the inner faces of the clamps may be either flat or curved, to suit them to hold bottles of varying shapes and sizes.

See cut under Glass.

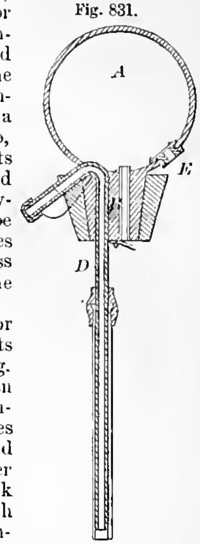
Bot′tle-jack. 1. (*Culinary.*) A roasting-jack of a bottle shape, suspended in front of a fire, and giving a reciprocating rotation to the meat which depends therefrom. It is operated by clock-work mechanism.

2. A form of lifting-jack, so called from its resembling a bottle in shape.

Bot′tle-mold′ing. (*Glass.*) A process adopted with most kinds of merchantable bottles of staple kinds. The bulb of glass on the end of the blow-tube is partially expanded, and then placed between the parts of an iron mold which is open to receive it. The parts are closed and locked, and the bulb then expanded by the breath to completely fill the mold.

In 1822, Rickets, of Bristol, England, obtained a patent for a bottle-molding apparatus, comprising a frame for holding and operating a bottle-mold. The mold consisted of a die for forming the body of the bottle, a two-part die for forming its top, and a plunger for shaping its bottom; these are reciprocated by means of treadles and levers. The frame is adapted to be used with dies of various sizes and shapes. The molten glass is blown out, so as to fill the mold in the ordinary way.

Fig. 831.

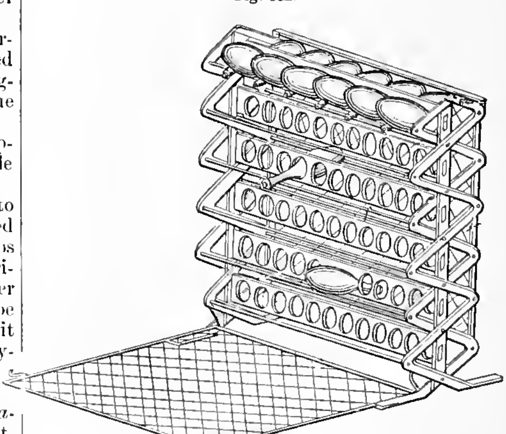


Bottle-Pump.

Bot′tle-pump. A device for withdrawing the fluid contents of a vessel without pouring. That illustrated comprises an elastic bulb *A*, having air induction and eduction apertures *E B*, provided with valves and a curved pipe *D*, whose longer branch is inserted into the neck of the bottle, the orifice of which is closed by the plug *B*. Compressing the elastic bulb drives air into the bottle, and expels the liquid through the pipe and nozzle.

Bot′tle-rack. The rests are so arranged that by inserting the bottles alternately neck and butt, a greater number may be stored within a given space. The hinged frame is for the purpose of securing the bottles in place during transportation.

Fig. 832.



Bottle-Rack.

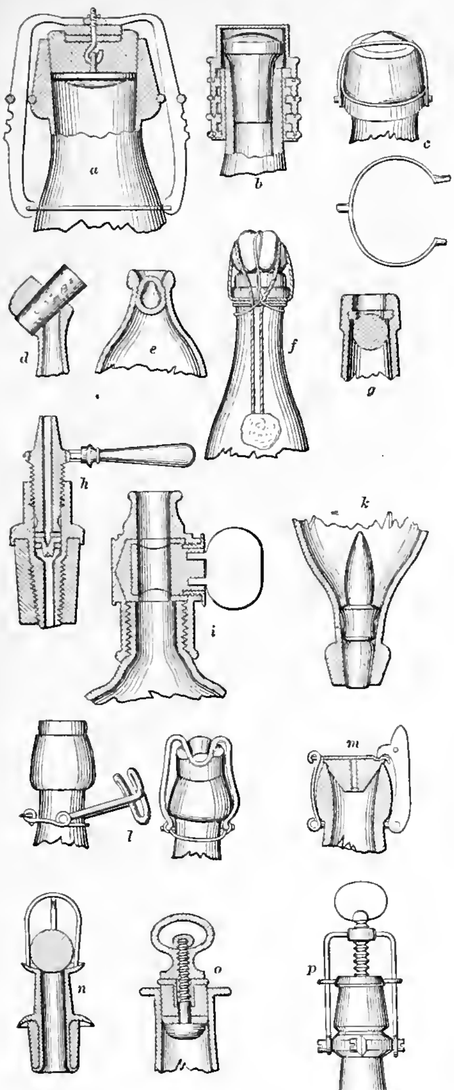
Bot′tle-screw. A corkscrew.

Bot′tle, Si′phon. A bottle having a tube which discharges the contents by a pipe which reaches nearly to the bottom, so as to eject liquid, as long as any remains, unmixed with the air. See Figs. 46, 48, pp. 18, 19.

Bot'tle-stop'per. A device for closing the mouths of bottles. It usually consists of a cork and a means of holding it in place against the pressure of the bottle's contents.

In some cases a composition is substituted for the cork.

Fig 833



Bottle-Stoppers.

a has a bail carrying the stopper, and the spring arms, which are permanently fixed in an annular recess in the swelling of the bottle-neck, catch into notches of the bail, and hold it and the stopper securely.

b is a permutation-lock stopper, set on a given combination, and holds a cap over the stopper.

c is a hinged bail, which is attached to a ring on the neck. The latter has a divided section which allows it to open.

d has a diagonal opening through the neck of the bottle. The pressure of the gas is upon the side of the cork, and does not tend materially to expel it. The cork may be ejected by a push, without a cork-screw.

e is a hollow rubber ball, driven by the pressure of gas against the inside of the neck. Removed by pressure of a rod, and floats on the liquid.

f is a method of tying champagne corks.

g is a bottle having a neck molded with an interior annular recess, filled by a packing-ring against which a glass ball is sustained by pressure of the gas.

h is a screw-faucet which has a packing against the lower end, which is depressed against a seat.

i is a simple bottle-faucet or one-way cock. It is opened by a key.

k is a glass rod which carries a packing around its enlarged head; one of its tapering ends guides it into its position in the neck of the bottle.

l is a hinged wire bail bent into U-form, so as to be swung up on to the cork while the latter is held by the plunger of the bottling-machine.

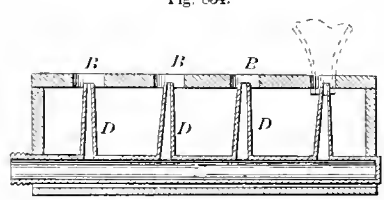
m is a rubber stopper, hinged on one side, and held on the other by a catch.

n is a glass ball, seated on the lip by gravity, and restrained by a cage when the bottle is tilted to discharge the liquid.

o is a stopper of rubber compressed between two disks brought together by a screw, and thus expanded against the inside of the neck.

p is a bail hinged by a collar around the bottle-neck, and having a screw which compresses the rubber-faced cap.

Fig. 834.

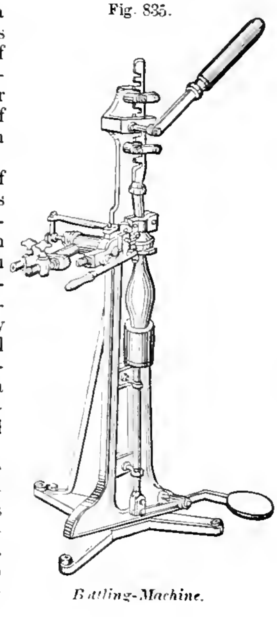


Bottle-Washer

Bot'tle-wash'er. A device for cleansing the interior of bottles. The example consists of a table having apertures *B* for the insertion of the necks of the bottles, into which water is forced by means of pipes provided with nozzles *D*.

In another form of the machine the bottles are placed in a horizontal position between base-plates coated with india-rubber and stoppers of the same material. Being previously about one third filled with shot, eight bottles are arranged in a circle around a horizontal spindle, and eight more in a second group around the same spindle. A rapid reciprocating motion is then given to the spindle, which also turns on its axis, so as to bring all parts of the

Fig. 835.



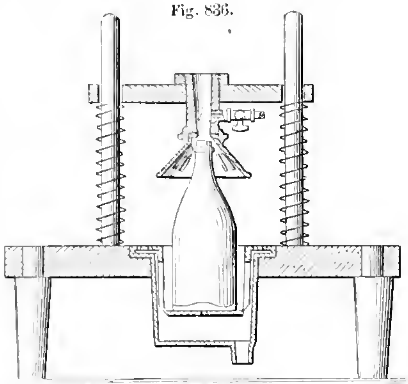
Bottling-Machine.

bottle successively into the lowest position. Thus 16 bottles are washed at once, and at the rate of 45 gross per day. An enlarged form of the machine is used for kegs and barrels.

Bot'tling-ma-chine'. A machine for filling bottles and corking them. The example (Fig. 834) is constructed to fill with soda-water or with soda-water and syrup combined. It first injects a graduated amount of syrup into the bottle, and then the water.

In Fig. 836 is shown a bottling-machine in which the bottle stands in a metallic cup, and the lip is

Fig. 836.



Bottling-Machine.

centered by the pressure upon it of an inverted funnel, depressed by a spring. The liquid is introduced at the faucet, and the cork is driven in through the vertical tube.

Bot'tling-pli'ers. Pliers specifically adapted for fastening wires over the corks and necks of bottles and for cutting off the surplus.

Bot'tom. 1. (*Fort.*) A circular disk with holes to hold the rods in the formation of a gabion.

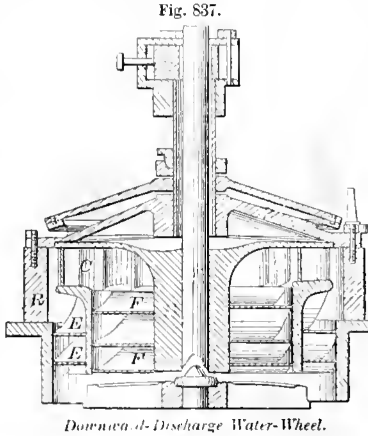
2. (*Shipwrighting.*) The planks forming the floor of a ship's hold.

3. (*Ordnance.*) One of the plates by which grape or canister is built up into a cylinder suitable for loading into the gun. Cast-iron tops and bottoms for grape; wrought-iron for canister.

4. (*Machinery.*) Cogs are said to *bottom* when their tops impinge upon the periphery of the coacting wheel.

A piston which strikes or touches the end of its cylinder is said *to bottom.*

Fig. 837.



Downward-Discharge Water-Wheel.

Bot'tom-dis'charge Water-wheel. A turbine from which the water is discharged at the bottom instead of at the sides. In that illustrated, the stream is admitted horizontally at the sides into the vertical buckets *C*, through which it passes, and then acts while descending upon inclined buckets *F*. The lower flow descends over the inclined buckets *E* at the periphery of the wheel. The balanced gates *R*, for admittance of water, are opened by segmental racks on their shafts, which engage with similar racks on an upper wheel.

Bot'tom-heat. Artificial temperature beneath the surface of the soil in a forcing-house.

Bot'tom-ing. 1. (*Civil Engineering.*) The foundation of a road-bed.

2. (*Railroad Engineering.*) Ballasting beneath and around ties.

Bot'tom-ing-hole. (*Glass-making.*) The open mouth of a furnace at which a globe of *crown glass* is exposed during the progress of its manufacture, in order to soften it and allow it to assume an oblate form.

Bot'tom-lift. (*Mining.*) The deepest lift of a mining-pump, or the lowest pump.

Bot'tom-plate. (*Printing.*) A plate of iron belonging to the mold of a printing-press, on which the carriage is fixed.

Bot'toms. 1. (*Mining.*) The deepest workings.

2. (*Metallurgy.*) Heavy and impure metallic products of refining, found at the bottom of the furnace in some of the stages of the copper-smelting processes.

Bot'tom-tool. (*Wood-turning.*) A turning-tool having a bent-over end, for cutting out the bottoms of cylindrical hollow work.

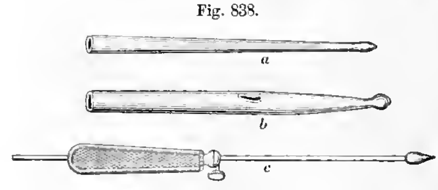
Bouche. A cylinder of copper in which the vent of a piece of ordnance is drilled. It has an exterior screw-thread cut on it, so that it may be removed when the vent becomes worn, or a new bouche substituted.

Bouch'ing. The gun-metal bushing of a block-sheave around the pin-hole.

Bouge; Bowge. (*Nautical.*) A rope fastened to the middle of a sail to make it stand closer to the wind.

Bou-gie'. (*Surgical.*) A smooth, flexible, elastic, slender cylinder, designed to be introduced into the urethra, rectum, or esophagus, in order to open or dilate it in cases of stricture or other diseases.

Fig. 838.



Bougies.

The slenderer forms of bougies are adapted for the *urethra*, the larger for the *rectum*, *vagina*, and *esophagus*. They are said to have been invented by Aldereto, a Portuguese physician, and were first described by Amatus, one of his pupils, in 1554. They are made either solid or hollow, and are sometimes medicated. Pickel, a French medical professor, gives the following recipe for their manufacture: 3 parts of boiled linseed-oil, 1 of amber, and 1 of oil of turpentine, are to be melted and well mixed together, and spread at three successive intervals upon a silk cord or web. The pieces thus coated are then to be placed in a stove heated to 150° F., and allowed to remain for 12 hours, 15 or 16 fresh layers of the composition being added in succession until the bougies are brought to the required size. They are next polished with pumice-stone, and afterwards smoothed with tripoli and oil. In Paris, which is the chief seat of the manufacture of these articles, one seventh of its weight of caoutchouc is dissolved in the oil, to render the compound more solid. For this purpose the caoutchouc is cut into slender filaments and added to the hot oil. Each successive layer is first dried in a stove, and then in the open air, before another is applied. For the best, or *elastic* bougies, the process requires two months for its completion; these should bear twisting around the finger without cracking or scaling, and be capable of stretching without giving way, but retract on being let go.

For hollow bougies an iron wire is introduced into the axis of the silk tissue, and withdrawn when the bougie is finished. Some are made with a hollow axis of tin foil rolled into a hollow tube. They are also made entirely of caoutchouc, dissolved in sulphuric ether.

An *armed bougie* is one with a piece of caustic fixed in its extremity.

HUNTER's bougie is a rolled piece of soft linen dipped, previous to rolling, in a composition of

Yellow wax	2
Red lead	3
Olive-oil	6

Finish off on a polished slab.

Caoutchouc bougies are made by applying a solution of india-rubber to the silk cord.

Gutta-percha bougies must be made of the best material, as their breaking *in situ* may prove fatal. It is better to use a silk cord, covered with the desired composition.

OTIS's *bougie à boule* (*c*) has a rounded and elongated head fixed on the stem, which slides through a handle and is held fast by a set screw.

a is an ordinary bougie.

b a bulbous bougie.

Boul'der-head. (*Hydraulic Engineering.*) A work of wooden stakes to resist the encroachment of the sea.

Boul'der-ing-stone. (*Metal-working.*) A smooth flint stone, used by cutlers to smooth down the faces of *glazers* and emery-wheels.

Boul'der-pav'ing. Paving with round water-worn boulders, set on a graded bottom of gravel.

Boul'der-wall. (*Masonry.*) One made of boulders or flints set in mortar.

Boul'tine. (*Architecture.*) A convex molding, whose periphery is a quarter of a circle, next below the plinth in the Doric and Tuscan orders.

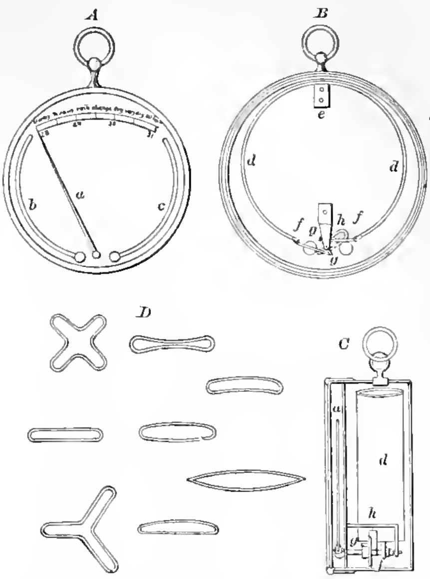
Bound. The path of a shot comprised between two *grazes*. See RICOCHET-FIRING.

Boun'da-ry-line. (*Shipbuilding.*) The trace of the outer surface of the skin of a ship on the stem, keel, and stern-post. It corresponds with the outer edge of the rabbet in those parts of the structure.

Bour'don Ba-rom'e-ter. The metallic barometer invented by Bourdon, of Paris, 1849, consists of an elastic flattened tube of metal bent to a circular form and exhausted of air, so that the ends of the tubes separate as the atmospheric pressure is diminished, and approach as it increases.

In Fig. 839, *A* is a front view, showing the hand or indicator *a* and the scale; *b* and *c* represent ordinary mercurial thermometers attached to the face. *B* is a back view, showing *d*, the tube, secured at its middle *e*, and having its ends connected by links *f f* to two short levers *g g*, on the same axis as the hand *a*, and operating, by means of the link-connections, to multiply its motion as the ends of the tubes

Fig. 839.



Bourdon Barometer.

approach or recede. *h* is an open plate which may be sprung apart, so as to allow the adjustment of the levers and hand to any particular range.

C is a transverse vertical section.

D represents sections of various tubes which may be employed.

The more approved forms of steam and vacuum gages are now constructed on this principle.

The *Bourdon* is commonly known as the *metallic barometer*, although the *aneroid* is also metallic, and both *holosteric*.

Bour-geois'. (*Printing.*) A size of type between *Brevier* and *Long Primer*.

Brevier, 112 ems to the foot.
Bourgeois, 102 ems to the foot.
Long Primer, 90 ems to the foot.

Bou-tant'. (*Architecture.*) An arc-boutant is an arch or buttress serving to sustain a vault, and which is itself sustained by some strong wall or massive pile. A flying-buttress.

Bow. 1. (*Archery.*) An instrument for projecting an arrow. It consists of a strip of wood or other material, the ends connected by a string. The bow is bent by retraction of the string, and the recoil imparted to the latter projects the arrow. In its simple state, and when large enough to be used for military purposes or for destroying large animals, it is known as the long-bow; when mounted transversely in a stock, it is a cross-bow. The former is exclusively adapted for shooting arrows; while bolts, or even round projectiles, may be thrown by the latter.

The long-bow, owing to its greater portability and capability of rapid discharge, was a much more effective weapon than the cross-bow, and continued in use for a long time after the introduction of fire-arms. The English archers, like the Egyptians in the time of Rameses the Great, were taught to draw the arrow to the ear, instead of to the shoulder, as was the practice elsewhere, and hence constituted a most effective species of force almost unknown in the other armies of Europe. 220 yards from the butt or target was the smallest distance allowed for practice by a full-grown man, according to the English archery-statutes. The cross-bow, as used by the Genoese, whose archers were in high repute in the Middle Ages, was a cumbrous and heavy weapon bent by a small windlass, and incapable of rapid loading and discharge.

For illustrations see "Iconographic Encyclopedia," "Frost's Pictorial History"; and for descriptions see "Gibbon's History" and other works treating of ancient and mediæval military tactics and weapons.

The use of the bow is of great antiquity. Plato credits Apollo with the invention. Ishmael became an archer (Gen. xxi. 20). The Philistine archers overcame Saul (1 Sam. xxxi. 3). David commanded it to be taught (2 Sam. i. 18). Aster of Amphipolis shot Philip of Macedon, and was hanged therefor. An ancient Egyptian bow is preserved in the Abbott Museum, New York, together with the leather case that contained it and fastened it to the war-chariot. Four arrows, made of reed and tipped with flint-stone, are suspended with it.

The Scythian bow was remarkable for its great curvature, being nearly semicircular.

The Lycian bow was made of the cornel-tree; those of the Ethiopians of the palm-tree. The horn of the antelope was used in the East for bows, at least as far back as the siege of Troy, and is still employed for the purpose. The English long-bow was made of yew or ash.

The Indian contingent of the army of Xerxes had bows of cane and arrows of cane with iron points. They wore cotton dresses. (Herodotus vii. 65.)

The arrow-heads of the Ethiopians were of agate and other siliceous stones. "Pieces of stone of the kind used in engraving seals."—*Ibid.*

The bows of the Ethiopians were of the stem of the palm-leaf.

Pliny says: "It is by the aid of the reed that the nations of the East decide their wars. Fully one half of mankind live under a dominion imposed by the agency of the arrow." The Eastern reed, so called, was a bamboo.

Harold, William Rufus, and Richard I. were killed by arrows. Crecy, Poictiers, and Agincourt were won by archers. The long-bow of that time measured six feet, the arrow three feet. The range was 300 to 500 yards.

In the Southwest of England bows and arrows did not finally disappear from the muster-roll till 1599. The muskets were such miserable affairs that in the middle of the fifteenth century it took fifteen minutes to charge and fire one.

2. (*Husbandry.*) The bent piece which embraces the neck of an ox, the ends coming up through the yoke, above which they are fastened by a key.

3. (*Machinery.*) An elastic rod and string for giving reciprocating rotation to a drill. See BOW-DRILL.

4. (*Drawing.*) An elastic slip for describing curves. An *arcograph.*

5. (*Hat-making.*) A piece of elastic wood, six feet long, and having a catgut string stretched between its extremities. The vibrating string operates upon the felting-hair on a grid called a *hurdle*, lightens up the fibers, assembles them into a bat, and drives out the dust. See BOWING.

6. (*Masonry.*) A projecting portion of a building of circular or multangular plan.

The bow-windows of English domestic architecture are known as *oriels.*

7. (*Vehicles.*) A bent slat to support the hood, canopy, cover, or tilt of a vehicle; otherwise called a *slat.*

8. (*Music.*) A number of long horse-hairs stretched upon an elastic rod, and used to vibrate the strings of instruments of the viol class.

9. (*Lock.*) The loop of a key which receives the fingers.

10. (*Weapon.*) The arched guard of a sword-hilt or of the trigger of a fire-arm.

11. (*Saddlery.*) The arched forward part of a saddle-tree which straddles the horse's back.

12. (*Nautical.*) An old nautical instrument for taking angles. It had one large graduated arc of 90°, three vanes, and a shank or staff.—ADMIRAL SMYTH.

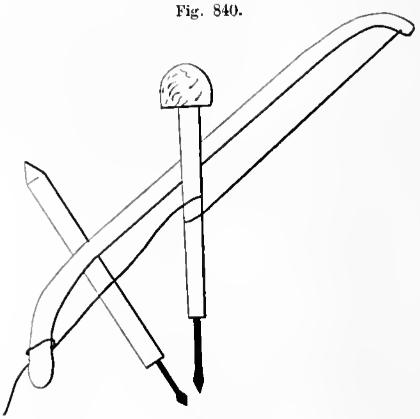
Bow. The fore end of a ship or boat.

Bow-com'pass. (*Mathematical Instrument.*) For drawing curves of large radius. It consists of a pliable strip which is bent by screws to any curve. An *arcograph.*

Bow-drill. A drill operated by means of a bow, the cord of which is given one or more turns around the handle of the drill, and alternate revolution in opposite directions imparted to it by alternately reciprocating the bow backward and forward.

The most ancient drill of which we have any authentic representation is the bow-drill. The annexed cut is from a painting in a tomb at Thebes, where one drill is shown in its detachable socket, and another one disconnected. So much pains did the artist

Fig. 840.

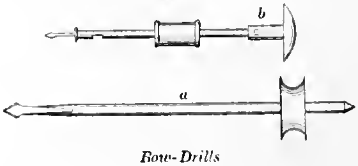


Bow-Drill.

take to make all plain to the comprehension of the spectator of future ages. It was for such they were painted, as the tombs themselves were occupied by the mortal remains which they expected to be again tenanted by the same mind and soul.

The various tools employed in chair-making are shown in the hands of the workmen or hanging on the wall. The saw and the adze were the principal shaping-tools. The parts of the chair were secured together by tenon and mortise, fastened by wooden pins. See the chairs in Dr. Abbott's collection, New

Fig. 841.

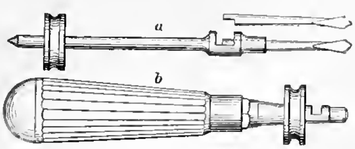


Bow-Drills

York Historical Society's Museum. The same collection has drill-bows and cords from Sakkarah and elsewhere.

The modern bow-drill is shown in Figs. 841, 842. *a* in each figure is designed to have a back-center in one of the holes in the end of the vise-cheek, in which case the work is held in the left hand and the bow

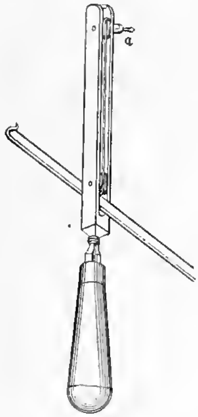
Fig. 842.



Bow-Drills.

in the right; or the drill-stock may have a handle *b* which is grasped in the left hand, pressing the drill upon the work, which is on the bench or in the vise, while the bow is operated by the right hand.

Fig 843.



Bow-Drill.

FREEMAN'S drill, instead of a bow, has a flat strip of wood with a facing of india-rubber, which has sufficient frictional adhesion to the wooden pulley on the drill-stock to rotate it by pressure, when the flat strip is reciprocated like a violin bow.

Fig. 843 shows a pair of pulleys driven by a catgut cord as the bow is reciprocated. The bow-string is wound around one of the pulleys, and the axis of the other is a stock which holds the drill *a*, and enables it to be presented at right angles to the length of the stock.

Bow'er. (*Nautical.*) The usual working-anchors at the bow, known as *best* and *small*; not from any difference in size, but according to position. The *starboard* is the *best*; the *port*, the *small*.—ADMIRAL SMYTH.

Bow-fast. (*Nautical.*) A hawser at the bow, whereby a ship is secured alongside a wharf or other object.

Bow-file. A curved file. A *Riffler.*

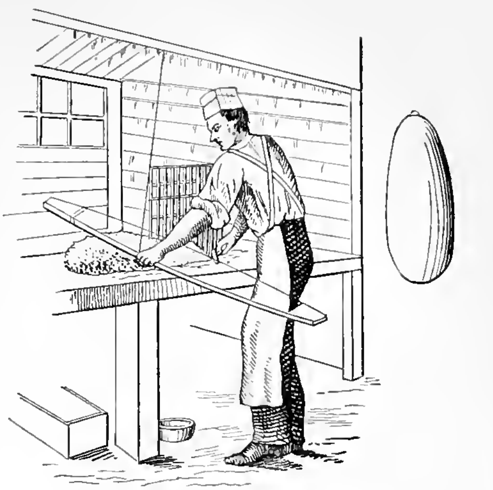
Bow-grace. (*Nautical.*) Or *Bon-grace.* A fender made of junk and ropes, lapping around the bow as a protection against floating ice.

Bow'ie-knife. A weapon used in the South and Southwest, and named after the inventor, who had a taste in that direction, and strongly insisted upon its superiority to the ordinary stiletto.

Bow'ing. (*Hat-making.*) A mode of separating the filaments of felting-fur, and distributing them lightly in an openwork frame, called a *basket.* The oval sheet of fur thus obtained is worked by pressure, and a rubbing jerking motion, which causes the fibers to interlace (felt), so that the sheet of napping can be handled and shaped by the succeeding processes.

In *bowing*, the amount of fur is weighed out, placed in a wad on the bench, and, the bow being held over it, the string is twanged by a wooden pin in the hand of the workman, so as to pick up a quantity of the filaments at each vibration, and throw them on to the *basket*, or wire screen.

Fig. 844.



Bowing.

Bow-in'stru-ments. (*Music.*) A term including that class of stringed instruments which are played by means of a bow. The violin, violoncello, double bass, etc.

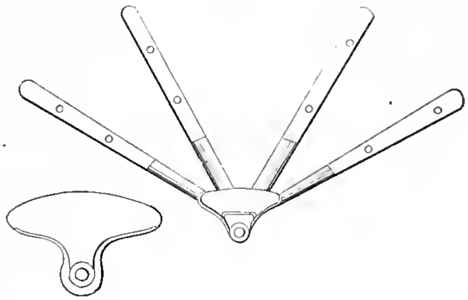
Another class of stringed instruments is played by the fingers or plectrum; as the guitar, harp, harpsichord, etc.

Another class is represented by the piano-forte and dulcimer, the strings being vibrated by a hammer.

Another by the air; as the æolian.

Bow-i'ron. (*Vehicle.*) The staple on the side of a wagon-bed which receives the bows of the tilt or cover, as in Fig. 845.

Fig. 845.



Bow-Iron.

Bowk'ing. The process of boiling in an alkaline lye in a kier. *Bucking.*

Bowl. (*Knitting-machine.*) A roller or antifriction wheel, on which the carriage traverses. A *truck*, in Nottingham parlance.

1. An open vessel of segmental or frusto-conical form, for containing liquids; larger and proportionately less deep than a cup.

"The Thibetans have no porcelain, but their potteries are, nevertheless, of great excellence. The wooden bowls, which every one carries, are made of the root of certain trees which grow on the mountains of Thibet. They are of a simple but elegant form, and have no other decoration than a slight coating of varnish, which does not hide either the natural color or the veins of the wood. Some of these bowls may be purchased for a few pence, and others are valued at one hundred ounces of silver. . . . . To us they seemed all alike. . . . . They say that some have the power of neutralizing poisons." (Abbé Huc's "Travels in Tartary," etc.) Each Tartar carries his bowl in the bosom of his robe.

2. The hollow open part of anything, as of a spoon, a tobacco-pipe, etc.

3. A ball; more particularly, a large wooden ball used in the sport of bowling.

Bow'line. (*Nautical.*) A rope connected by *bridles* to the middle of the *leech* of a square sail, and passing forward, so as to keep the weather-edge of the sail well forward when sailing *close-hauled*, and enable the ship to come nearer to the wind. *On a bowline:* sailing close or *close-hauled.*

Bow'line-bri'dle. (*Nautical.*) The span which connects the bowline to several cringles on the leech of a square sail.

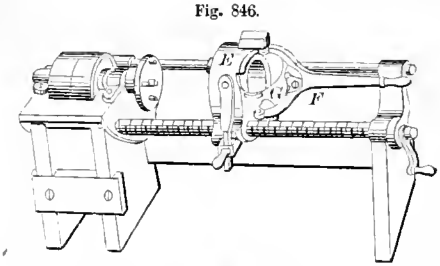
Bow'line-knot. (*Nautical.*) A peculiar knot by which bowline-bridles are fastened to the cringles. See KNOT.

Bow-lines. (*Shipbuilding.*) Curves representing vertical sections of the bow-end of a ship.

Bowl-ma-chine'. A machine for making wooden bowls.

The solid cylindrical blank is clutched by the rear end in the lathe, and its forward end turns in the

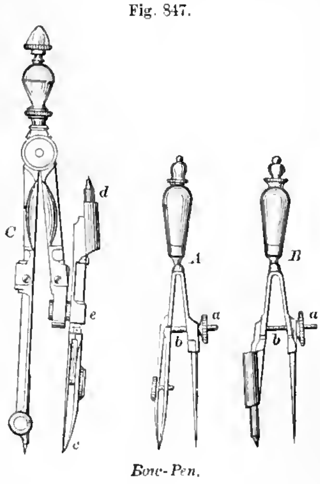
Fig. 846.



Bowl-Machine.

cylindrical rest *E*, which is adjustable longitudinally, and gives fulcrum-bearing to the lever *F* carrying the curved cutting-tool *G*. The blank is rotated and the bowl cut by sweeping the lever around a curve of 90°. The necessarily increased thickness of the bottom gives opportunity to remove a plano-convex disk to form a flattened bottom.

Fig. 847.



Bow-Pen.

Bow-net. (*Nautical.*) A lobster-trap made of two round wicker-baskets, one thrust within the other, and having a lip to oppose the return of the fish.

Bow-pen. (*Mathematical Instrument.*) A form of compasses for the finer and more minute parts of mechanical and architectural drawing. The legs are opened by the elasticity of the bow, as the nut *a* is receded on the screw *b*, and are approached by the contrary motion of the nut. It is a small pair of compasses, and may be of similar construction to the larger; that is, the legs may be united by a rivet, dispensing with the bow. Some of them have shifting legs, so as to substitute pen, pencil, the ordinary point, or the needle-point. They then lack all the specialties of the bow-pen except size.

C (Fig. 847) shows a revolving bow pen and pencil, so called, although the bow is absent. The pen *c* and pencil *d* are at the respective ends of a leg which rotates on an axis *e* to bring either into position.

A is a *spring bow-pen.*

B a *spring bow-pencil.*

Bow-pen'cil. A form of compasses of the smaller kind which are capable of delicate adjustment for describing minute circles and arcs of small radius. The mode of adjustment is similar to the bow-pen. It is also tolerably evident from the figure. A black lead-pencil pared down to a small size, or the lead from a pencil, is clamped in the socket, and is advanced as it wears or is shaved away in sharpening. See BOW-PEN, *B*.

Bow-pin. (*Husbandry.*) A cotter or key for holding in place the bow of an ox-yoke.

Bow-saw. A saw having a thin blade, kept taut by a straining frame in the manner of a bow and string. A *sweep-saw* or *turning-saw.* See FRAME-SAW.

Bow'sprit. (*Nautical.*) A spar projecting forward from the bows of a vessel. It supports the jib-boom and flying jib-boom, and to it and these spars the fore-stay, fore topmast-stay, etc., are secured. It is tied down by the *bobstays* and by the *gammoning.* It is stayed laterally by the *bowsprit-shrouds.* It rests upon the *stem* and the *apron.*

The part which rests on the *stem* is the bed; the inner part from that point is the *housing;* the inner end is the *heel;* the outer end the *head* or bees-seating.

The *gammoning* is the lashing by which the bowsprit is secured to the *knee* of the *head.*

The *martingale* is a spar depending from the bowsprit-end, and is used for reeving the stays.

The *heel-chain* is for holding out the jib-boom, and the *crupper-chain* for lashing it down to the bowsprit.

The bowsprit has —

Heel.	*Bobstays.*
Head.	*Shrouds.*
Fiddle or *bees.*	*Martingale.*
Chock.	*Dolphin-striker.*
Gammoning.	

Bowsprits are *standing*, that is, permanent, as in large vessels or sloops; or *running-in* bowsprits, as in cutters.

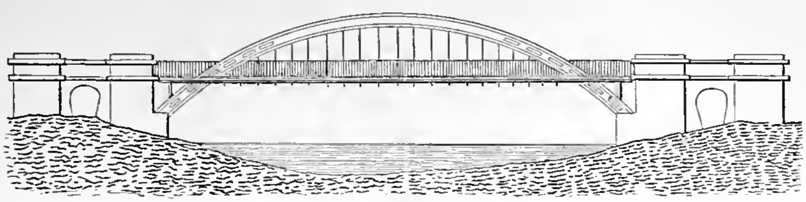
Bow-string Bridge. One in which the horizontal thrust of the arch or trussed beam is resisted by means of a horizontal tie attached as nearly as possible to the chord-line of the arch.

Girders and beams have also been constructed in the same way. The arched-beam roof of the New York and Harlem Railway Depot, New York, illustrated opposite to page 139, is of this character.

The roadway forms a chord, and is supported by tension-rods from the arches which span the space between abutments.

The Howslett bridge, erected by Mr. Leather, has a span of 152 feet; versed sine, 33 feet; hight above water, 43 feet; width, 33 feet; cost, £4,200.

Fig. 848.



Bow-String Bridge at Howslett, England.

Bow-string Gird'er. A *bow-string girder* consists of an arched beam resisting thrust; a horizontal tie resisting tension and holding together the ends of the arched rib; a series of vertical suspending-bars by which the platform is hung from the arched rib; and a series of diagonal braces between the suspending bars. See previous article.

Bow'tel. (*Architecture.*) The shaft of a clustered pillar, or a shaft attached to the jambs of a door or window.

Bōw'tell. (*Architecture.*) A plain circular molding.

Box. A receptacle in which something else is held or contained, frequently deriving its specific name from the article it is intended to contain; sometimes from its mechanical purpose or association, or its material.

Axle-box.	Pepper-box.
Ballot-box.	Plant-box.
Cartridge-box.	Post-office box.
Fare-box.	Railway-car axle-box.
Fruit-box.	Resistance-box.
Hat-box.	Signal-box.
Journal-box.	Stuffing-box.
Letter-box.	Thread-box.
Match-box.	Ticket-box.
Paper-box.	Wheel-hub box.

The more important of these will be considered under their alphabetical heads.

The boxes of ancient Egypt were made with great neatness, the lids being hinged in various ways and well fitted. In the Abbott Museum, New York City, and in other collections, are many specimens. For example: —

Carved mummy-cases built up of parts doweled together, or of single blocks, forming the case and lid respectively, hollowed out by the adze and scorper.

Boxes carved in the shape of cats, and hollowed out to receive mummies of those animals. The cases are painted and have glass eyes.

Boxes carved like scarabæi, and used to contain unguents. Others bored like reeds, to hold the *kohl* used to blacken the eyelids, as in the days of Jezebel.

The boxes have sliding or hinged lids in great variety, and some of them in excellent taste. They are made of wood, stone, bone, marble, porcelain, hippopotamus tooth, etc., and are inlaid, carved, painted, and decorated with ornaments.

2. (*Machinery.*) *a.* A journal-bearing. It usually consists of two brasses with semi-cylindrical grooves; one piece rests upon the journal, which lies in the other piece. See PILLOW-BLOCK; AXLE-BOX; CAR-AXLE.

b. A chamber in which a valve works.

c. See STUFFING-BOX.

3. (*Hydraulics.*) *a.* A pump-bucket. A hollow plunger with a lifting-valve.

b. The upper part of a pump-stock.

4. (*Locksmithing.*) The socket on a door-jamb which receives the bolt.

5. A drain with a rectangular section.

6. A square notch cut into a sugar-tree to start and catch the *sugar-water* (in the West) or the *sap* (in the Eastern States). It is considered more wasteful of the timber than tapping with the gouge or the auger.

7. (*Weaving.*) *a.* The pulley-case of a draw-loom on which rest the small rollers for conducting the tail-cords.

b. The receptacle for the shuttle at the end of the *shed.*

8. (*Printing.*) A compartment in a *case* appropriated to a certain letter.

9. (*Founding.*) A flask or frame for sand-molding.

10. (*Vehicle.*) *a.* The iron bushing of a nave or hub. See AXLE-BOX.

b. The driving-seat of a coach or close carriage.

11. (*Vise.*) The hollow screw-socket of a bench-vise.

Box and Tap. (*Machinery.*) A device for cutting wood screws for carpenters' benches, clamps, bedstead-rails.

Box-beam. (*Metal-working.*) A beam of iron plates secured by angle-iron, and having a double web forming a cell. See GIRDER.

Box-car. (*Railroad Engineering.*) A closed car intended for freight.

Box-drain. (*Hydraulic Engineering.*) An underground drain built of brick and stone, and of a rectangular section.

Box-frame. (*Carpentry.*) A casing behind the window-jamb for counterbalance-weights.

Box-gird'er. (*Building.*) An iron beam made of boiler-plate, the four sides riveted to angle-iron.

Box'ing. 1. (*Joinery.*) The casing of a window-frame into which inside shutters fold.

2. (*Shipwrighting.*) The scarf-joint uniting the stem with the keel.

3. (*Wood-working.*) The fitting of the shoulder of a tenon in the surface of the timber, which is mortised for the reception of the tenon.

4. A mode of cutting a deep and hollow notch into sugar or pine trees to catch the flow. The notch differs in the respective cases, but in each a piece is boxed out, and the process thus differs from the *boring* or *tapping* of the maple and from the *hacking* of the pine.

Box-i'ron. A hollow smoothing-iron, heated by a hot iron within.

Box-key. An upright key, used for turning the nuts of large bolts, or where the common spanner cannot be applied.

Box-lock. (*Locksmithing.*) A rim-lock fastened to the side of a door without mortising.

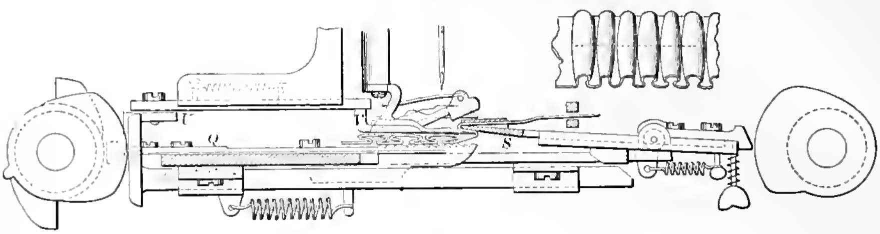
Box-mak'ing Machine'. One in which the bottom, side, and end pieces are set in place and their nails driven by advancing punches, which sink them into place.

Box-met'al. For bearings: copper, 32; tin, 5. Strubing's: zinc, 75; tin, 18; lead, 4.5; antimony, 2.5. See ALLOY.

Box-o'pen-er. (*Carpentry.*) A tool with a forked claw and a hammer-head, for tearing open boxes by lifting their lids, drawing nails, etc. Some combination tools have also a pincher and screw-driver.

Box-plait'ing. A device to fold cloth alternately in opposite directions, forming box-plaits on one side. Two plaiters *Q U*, one located directly above the other, reciprocate alternately in the direction of the feed-movement, and a third plaiter *S*, with a trough-like mouth, and containing the cloth to be laid in box-plaits, reciprocates also in the direction of the feed, and has also a rising and falling movement, so as to bend the cloth carried by it first over one plaiter and then under the other. Each time a

Fig. 849.

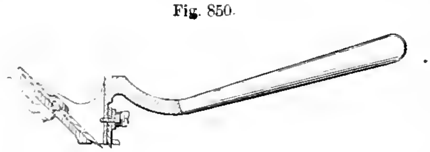


Box-Plaiting.

fold is so formed, it is caught and secured by the needle-thread, and the material is moved along by the feed for a new plait.

Box-scrap'er. (*Carpentry.*) A tool for erasing names from boxes. It is a mere scraper with an

Fig. 850.

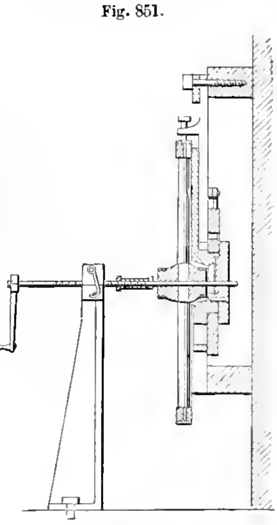


Box-Scraper.

edge presented obliquely, or, as in the example, works after the manner of a spoke-shave.

Box-set'ter. (*Wheelwrighting.*) A device for setting axle-boxes in hubs so as to be perfectly true. In the example the wheel is poised on its axis, and clamped by jaws above and below the hub. Its rim is held by grippers on radial bars which hold the wheel against stationary bearings in a plane perpendicular to the axis of the boring-spindle. The latter is mounted in the sockets, and carries cutters, which are fastened in a mortise in the spindle by means of a sleeve, screw-nut, and screw.

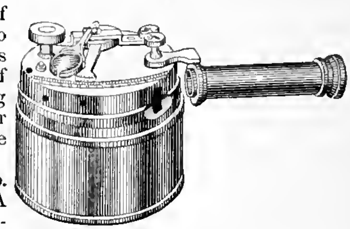
Fig. 851.



Box-Setter.

Box-Sex'tant. A small sextant inclosed in a circular frame. Used principally for triangulating in military reconnoisance, etc. It is on the principle of the ordinary sextant, having mirrors for bringing the reflected and direct images of an object into coincidence as a means of measuring their angular distance. See SEXTANT.

Fig. 852



Box-Sextant.

Box-slip. (*Plane.*) A slip of box inlaid in the beechwood of a tongueing, grooving, or molding plane, in order that the edge or the quirk may possess greater durability. The edges and quirks are rabbets or projections, which act as fences or gages for depth or distance.

Box-sta'ple. (*Carpentry.*) The *box* or *keeper* on a door-post, into which is *shot* the bolt of a lock.

Box-strap. (*Machinery.*) A flat bar, bent at the middle, to confine a square bolt or similar object.

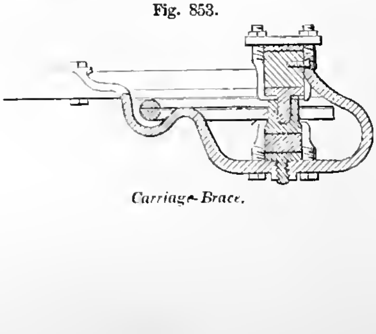
Box-turn'ing Ma-chine'. (*Turning.*) A lathe specifically adapted for turning wooden boxes and lids, for matches, spices, or other matters. Such lathes have convenient chucks, rests for the side-turning and for the bottoming tool which gives the flat bottom.

Boy'au. (*Fort.*) A trench of zigzag form, to avoid an enfilading fire, leading from one parallel of attack to another, or to a magazine or other point.

Brace. 1. (*Carpentry.*) A diagonal stay or scantling, connecting the horizontal and vertical members of a truss or frame, to maintain them at a prescribed angular relation.

2. (*Printing.*) *a.* A printer's sign; a crooked line connecting several words or lines; *vide*, ⁓.

Fig. 853.

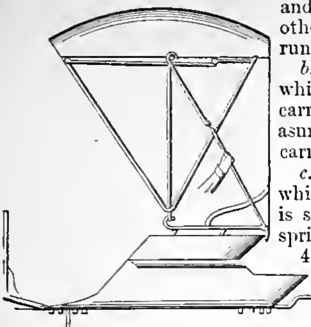


Carriage-Brace.

b. The stays of a printing-press, which serve to keep it steady in its position.

3. (*Vehicle.*) *a.* An iron strap passing from the head-block, behind and below the axle, and forward to another portion of the running-gear.

Fig. 854.



Carriage-Top Brace.

b. A jointed bar by which the bows of a carriage-top are kept asunder, to distend the carriage-top cover.

c. A thick strap by which a carriage-body is suspended from C-springs.

4. (*Boring-Tools.*) *a.* (*Wood-working.*) A revolving tool-holder, one end of which is a swiveled head or shield, which rests in the hand or against the chest of the operator; at the other end is a socket to hold the tool. Called also a *stock*, more particularly in metal-working.

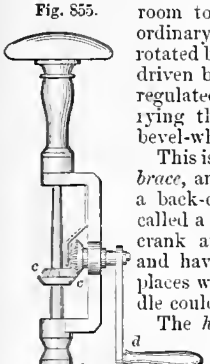
The varieties of the instrument principally hinge upon the mode of attaching the bit.

Varieties depending upon other differences are: —

Angle-brace; a corner drill.
Crank-brace; the usual form.
Hand-brace; with a swiveled breast-plate.
Lever-brace; worked with an oscillating lever, usually having a ratchet motion. See RATCHET-DRILL.

b. (*Machinery.*) The *angle-brace* is used in places, such as angles, where there is not room to revolve the handle of the ordinary brace. The drill-stock *a* is rotated by means of bevel-pinions *c c*, driven by a crank *d*. Speed may be regulated by changeable gearing, varying the relative sizes of the two bevel-wheels.

Fig. 855.



Angle-Brace.

This is sometimes called the *French brace*, and when made of metal with a back-center and feed-screw, it is called a *corner-drill*, being driven by crank and bevel-gearing as before, and having a capacity for reaching places where the ordinary brace-handle could not be revolved.

The *hand-brace* (Fig. 856), otherwise the *crank-brace*, has a socket for the bit, a crank for revolving it, and a swiveled head for the pressure of the hand or the breast of the workman.

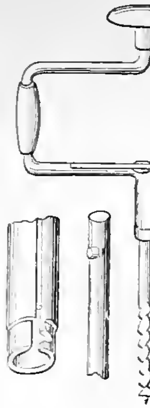
The machinist's brace depends upon a rigid bearing for the back-center *a* and a feed-screw *b* for keeping it to its work, the requirements being far beyond the pressure that can be given to a swiveled head by the breast of the workman. A sleeve *c* upon the handle rotates on the stock as the tool revolves.

An extension-shank is used as a temporary addition to the length of the tool, to enable the latter to reach deep-seated parts. The tang *d* fits into the socket *e* of the brace, and the tang of the drill into the socket *g* of the extension-piece.

5. (*Nautical.*) A rope passing from the end of the yard to another mast, and serving to trim the yards fore and aft.

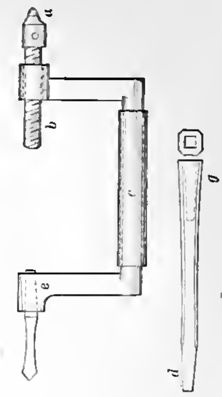
6. (*Shipwrighting.*) One of the eye-bolts on which

Fig. 856.



Hand-Brace.

Fig. 857.



Machinist's Brace.

the hooks of the rudder are secured. The *gudgeons* or *googings*.

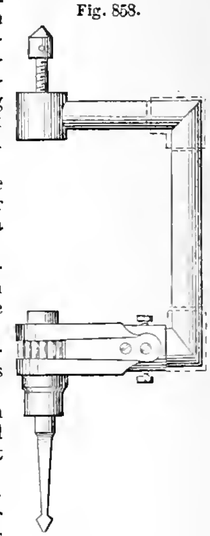
7. (*Music.*) One of the cords of a drum by which the heads are stretched.

8. (*Mining.*) The mouth of a shaft.

9. A stay for a trunk-lid or similar duty.

Brace-drill. (*Metal-working.*) A boring-tool shaped like a brace, having a tool rotated by the revolution of the handle. In the example, the motion may be continuous or reciprocating rotary, the swinging portion being connected to the cutter-stock by a pawl on the former and ratchet on the latter.

Fig. 858.



Brace-Drill.

The ratchet-head of the brace is attachable to a lever to form a swing-brace or a rotary brace-frame.

Brace-pen'dant. (*Nautical.*) A short pendant from the yard-arms, to hold the brace-block.

Brac'ing-chain. (*Vehicle.*) The chain which ties together the sides of a wagon, to prevent the load from breaking them apart. Used especially in wood and freight wagons.

Brack'et. A lateral projection from a wall, post, or standard, to strengthen or support another object; to strengthen an angle; to support a heavy cornice or an entablature.

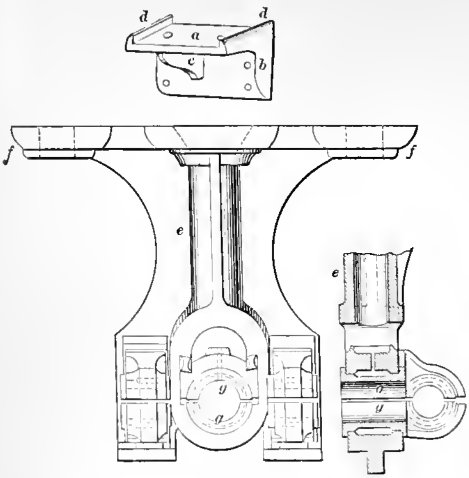
Of the parts of a bracket, —
a is the *sole*.
b the *wall-plate*.
c the *rib*.
d a *snug* or *flange*. See Fig. 859.

This description of support is also adapted for shelves, coves, soffits, and seats.

1. (*Machinery.*) The *shafting-bracket* (Fig. 859) is a hanger which contains the journal for shafting. *e* is the pedestal, supported by the extended arms *f f*, which are bolted to the joists of the ceiling. *g g* are the parts of the boxing which are in immediate contact with the shaft.

Brackets for shafting are known by different names, according to structure and position.

Fig. 859.



Brackets.

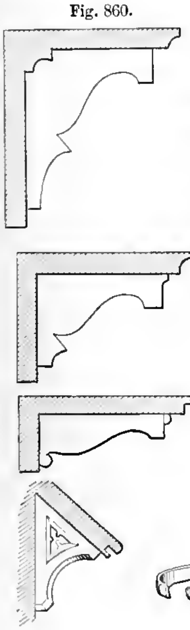
Pendent brackets or *hangers*, when the shafting is suspended from the ceiling.

Wall-brackets, when fixed against a perpendicular wall.

Wall-boxes, when the shaft passes through a wall or partition furnished with a bearing.

Pedestal-brackets, when the support rises from a foundation or bed-plate.

Fig. 860.



2. (*Architecture.*) *a.* An ornament in the shape of a console, standing isolated upon the face of a wall.

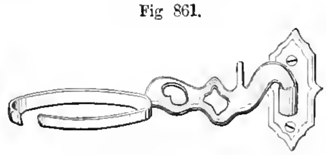
b. Roof-brackets are placed beneath the eave or the projection at the gable, and have shapes conforming to the style of the architecture or the necessities of their position. In some cases the bracket is so prominent a feature in the ornamentation as to confer the name on the style; thus we read of the *bracketed style*. See works on architecture.

3. A projecting device for supporting a lamp, etc.

4. A gas-fixture projecting from the face of a wall.

5. (*Ordnance.*) The cheek of a mortar-bed, or the carriage of a ship's or casemate gun.

Fig 861.



Roof-Brackets. *Lamp-Bracket.*

6. (*Shipbuilding.*) A timber-knee in a ship's frame, supporting the gratings.

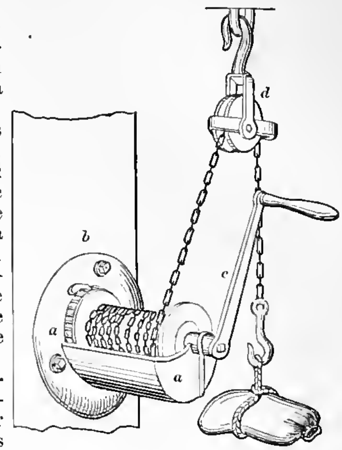
7. (*Steam-Engine.*) *a.* The pieces by which the boiler of a locomotive is maintained in position.

b. The pieces which hold and guide the slide-bars.

8. (*Printing.*) Signs ("[ ]") used to inclose a word or sentence, to isolate it from the other matter. The *bracketed* portion may be a note, protest, explanation, authority, reference, comment, rectification, interpolation, query, emphasis, etc.

Brack'et-crab. A hoisting apparatus, designed for attachment to a post, wall, etc.

Fig. 862.

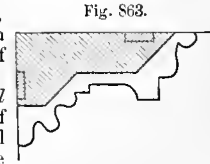


Bracket-Crab.

In the drawing the chain-drum is shown journaled in a frame *a*, attached by bolts to the post *b*, and is turned by the handle *c*. The tackle is shown as a single whip, the chain being rove through the single-sheave block *d*.

Brack'et-ing. A skeleton support for moldings. This plan is commonly adopted in making the arches, domes, sunk panels, coves, pendentive work, etc., at the upper parts of apartments. The brackets are got out, of the required contour, nailed into position, and form a basis for the reception of the lath and plastering.

Fig. 863.



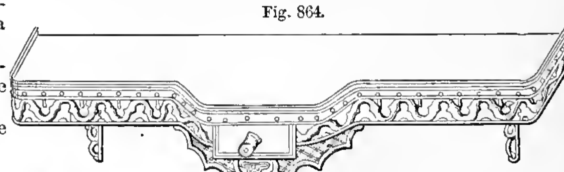
Bracketing.

In domed work, *spherical bracketing* is the forming of brackets to support lath and plaster work, so that the surface of the plaster shall form the surface of a sphere.

Spheroidal bracketing is the bracketing prepared for a plaster ceiling whose surface is to form that of a spheroid.

Brack'et-shelf. A form of console for supporting a pier-glass or other object.

Fig. 864.



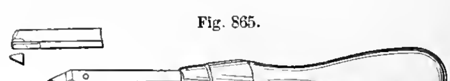
Bracket Shelf and Drawer.

Brad. A thin, square-bodied nail, whose head has a lip on one side only. See Nail.

Brad'awl. (*Joinery.*) A small boring-tool with a chisel-edge. Used for opening holes for the insertion of nails.

Brad-set'ter. (*Joinery.*) A tool which grasps

Fig. 865.



Brad-Setter.

a brad by the head, and by which it is driven into its appointed place.

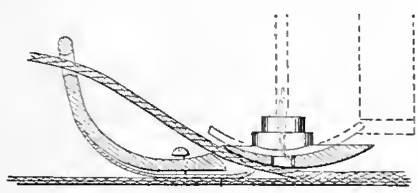
Braid. (*Fabric.*) A narrow woolen woven goods, used for binding.

Among the materials used for bonnet-braid may be mentioned, —

Bass or linden bark.	Worsted thread.
Cotton thread.	Linen thread.
Flax thread.	Straw.
Hemp.	Chip.
Horse-hair.	Paper strips.
Palm-leaf.	Wood splints.
Wool thread.	Majuaja.

Braid'er. A sewing-machine attachment provided with an opening to guide and lay a braid on the cloth under the action of the needle. The braid-guiding opening may be in the presser and in advance of the needle-hole, or in the cloth-plate, or in a separate attachment secured to the cloth-plate.

Fig. 866.

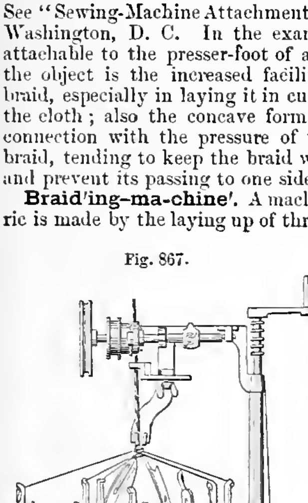


Braider.

See "Sewing-Machine Attachments," G. W. Gregory, Washington, D. C. In the example, the guide is attachable to the presser-foot of a sewing-machine; the object is the increased facility for guiding the braid, especially in laying it in curved directions on the cloth; also the concave form of the groove, in connection with the pressure of the spring on the braid, tending to keep the braid within the groove, and prevent its passing to one side thereof.

Braid'ing-ma-chine'. A machine in which a fabric is made by the laying up of three or more threads by a plaiting process. Mechanism guides the thread-holding bobbins in a serpentine course, to interlace the threads. Threads, from three to thirty, are twisted one around another by revolving wheels, spindles, etc., making braid, stay, and shoe laces, upholsterer's cord, and coach-lace. It is also employed for covering whips, threads of caoutchouc, the wires of crinoline, etc.

Fig. 867.



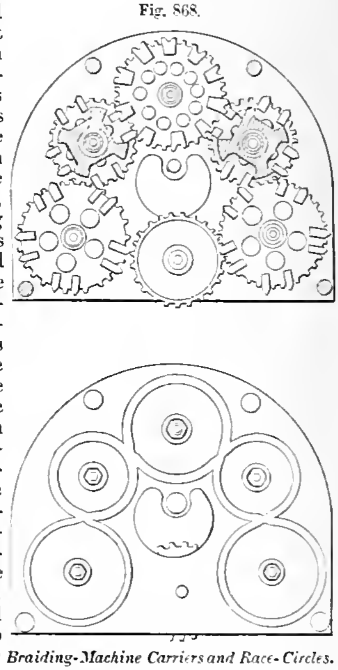
Braiding-Machine.

Braiding-machines are made of all sizes, from machines braiding seven strands to those braiding eighty-five, this being the limit at present of flat braids manufactured in the United States; though round braiders, or machines for covering tubes, are built capable of braiding ninety-six strands. The sizes of round braiders most largely in use, however, are those braiding sixteen and twenty strands, which are the sizes used in the manufacture of shoe-strings and covering hoop-skirt wires. The sizes of flat braiders most in use are those braiding fifty-three and sixty-five strands worsted yarn, which produce the common dress braids now so commonly worn. The production of American machines is about a million yards daily of dress braids.

The braid is passed through fire to relieve it of its floss, and prepare it for the dyer.

The views (Fig. 868) are respectively elevation and plan of a braiding-machine. The elevation shows the mode in which the spindles and bobbins are arranged relatively to the skirt-wire, around which the strands are being plaited. The lower figure shows a view of the carriers, and of the race-circles, in which the spindles are caused to move, so that they move in and out, crossing each other's paths, and thus interlace the strands. When the braid is to be laid up tubular, as in covering upholsterer's cord, whips, and skirt-wire, the set of race-circles form a continuous series around, and the spindles make the complete circuit, again and again repeating the serpentine course in the same direction. The upper figure represents a machine of this kind. When the braid is to be laid up flat, as in the drag and other common braids, each *racer*, as the spindle-holders are called, makes a single course, turns round the last race-circle of the series, and then returns, intersecting its own former path as it follows the circles shown in the lower part of the figure. The upper part shows the carriers which impel the racers, each one delivering the racer to the next carrier in series, which it impels along its allotted path in the circle. The two figures represent the carriers and race-circles of a machine for laying up flat braid. By a still farther refinement of the process, the machine is adapted for making two or more distinct braids connected at their edges; thus admitting of different-colored stripes. Each racer for this purpose goes only through its own course of race-circles, one of which circles is common to the two carriers.

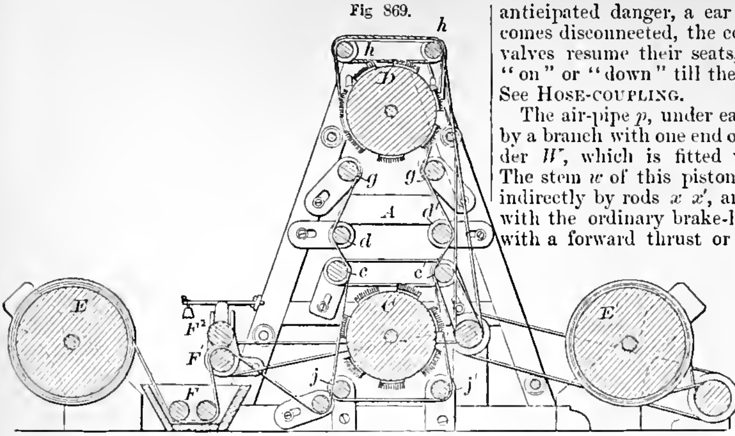
Fig. 868.



Braiding-Machine Carriers and Race-Circles.

Braid Siz'ing and Pol'ish-ing. The braid is passed from a reel E through a sizing-trough F, to pressure-rollers F' F^2, and then over guide and tension rollers $j\ c\ d\ g\ h\ h'\ g'\ d'\ c'\ j'$, which hold it obliquely against the brushes on drums C D. It is then drawn off by a reel E', which receives intermittent motion

Fig 869.



Braid Sizing and Polishing Machine.

from a toothed wheel actuated by projections on the end of the lower brush-shaft engaging with the teeth.

Brails. (*Nautical.*) Ropes used to gather up the foot and leeches of a sail, preparatory to furling.

The *brails* of a *gaff-sail* are for hauling the after-leech of the sail forward and upward, previous to furling: towards the *head* (*peak-brails*); *neck* (*throat-brails*); and *luff* (*foot-brails*). The *lee-brails* are hauled upon in furling.

Brake. 1. (*Railroad Engineering.*) A contrivance for stopping the motion of a car-wheel by friction applied thereto.

Car-brakes, until the advent of the atmospheric brake, were actuated by a winding drum, connecting chains and levers, the power of the brakeman being applied to a hand-wheel on the car platform. The principal modes of application of the hand-operated brake are explained under CAR-BRAKE (which see). In the same article are detailed a number of devices for the use of air, steam, the colliding of the cars, friction, feet on the track, etc., for arresting the motion of the cars.

The Westinghouse Atmospheric Brake, illustrated by the folding plate opposite, was patented in 1869, and has been adopted on many railway lines in the United States and in Europe. Its chief features are, first, the use of compressed atmospheric air as a means of applying the brakes; and, second, putting the whole braking-apparatus under the direct control of the locomotive engineer, so that he can apply the brakes at pleasure, instantaneously, or gradually, and with any desired power, limited only by the power of the air-compressing apparatus and the strength of the air-vessels. The construction of the apparatus is shown by elevation and section. A small but powerful direct-acting steam-engine *A* is secured to the frame of the locomotive above and between the driving-wheels. This engine operates the air-pump *B*, and thereby the air is compressed to any desired density into a receiver or reservoir *Y*, which is arranged under the cab. Each car is provided with a line of air-pipes *p p*, which are united between the cars by flexible hose *r r*, and suitable couplings. Each half-coupling contains a valve so constructed that, when the hose are coupled up, the valves are automatically unseated, so as to make an open continuous air-pipe through the train, and, when uncoupled, each valve will automatically resume its seat. Hence, the valve of the rear coupling of the rear car of a train will always be closed, and if, after the brakes are applied in view of actual or anticipated danger, a car jumps the track and becomes disconnected, the couplings will separate, the valves resume their seats, and the brakes be held "on" or "down" till the car comes to a full stop. See HOSE-COUPLING.

The air-pipe *p*, under each car, makes connection by a branch with one end of a cast-metal brake-cylinder *W*, which is fitted with an ordinary piston. The stem *w* of this piston is connected directly (or indirectly by rods *x x'*, and "progressive lever" *X*) with the ordinary brake-levers in such a way that, with a forward thrust or throw of the piston, the brake-shoes will be applied to the car-wheels, and by a reverse movement they will be released or "let off." A three-way cock *M* in the air-pipe, just outside the reservoir *Y*, is within reach of the locomotive engineer. In ordinary running all communication between the reservoir *Y* and the air-pipes *p* is closed. The engineer, at pleasure, turns the cock *M*, so as to open this communication, and permit the compressed air to flow back into the brake-cylinders *W*, either partially if he merely wishes to check the speed of his train on a down grade, or more completely for an ordinary stop, or instantaneously and fully in anticipation of immediate danger. By another adjustment of the cock, he closes the communication again, and opens a port for the escape of the compressed air from the brake-cylinders. The brakes are then "off," and the wheels free.

The construction is such as not to interfere with the ordinary operation of the brakes by hand. For ordinary passenger-trains, an air-pressure is commonly required of from 30 to 60 pounds per square inch. The capability of this brake is best shown by the following report of tests made.

At a test on the Kansas Pacific Railway, May 12, 1871, a train going at the rate of 45 miles an hour was stopped within a distance of 250 feet.

On September 18, 1869, a test was made on the Pennsylvania Railroad, at the famous "Horseshoe Bend." The train of six cars, running down a grade of 96 feet to the mile, at the rate of 30 miles an hour, was brought to a stand-still in 420 feet,—seven car-lengths.

The steam-ejector has also been employed by Mr. Westinghouse, under a patent granted to him in 1871, for exhausting the air from the brake-cylinders in front of the pistons, and thus applying the brakes by a "vacuum" or atmospheric pressure. See GIFFARD INJECTOR.

2. (*Machinery.*) A friction strap or band applied on the periphery of the drum of a hoisting-machine, crane, or crab.

Or it may consist of a pivoted lever, having a shoe at one end, and a rope attached to the other, by pulling which the shoe is pressed against the rim of the wheel.

Of this class is the rim of wood surrounding the inclined wheel attached to the sail-shaft of a wind-mill, and pressed down thereon by a lever to stop the mill.

3. (*Vehicle.*) *a.* A vehicle for breaking horses, consisting of the running-gears, and a driver's seat, without any carriage-body.

b. A rubber pressed against the wheel of a vehicle, to impede its revolution, and so arrest the descent of the vehicle when going down hill.

The old Herodes Atticus, the rhetorician, refers to

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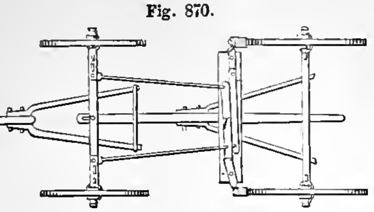
the *fetter to the wheels,* used when his chariot was descending a hill. It appears to have been only a stick put through the wheels.

The example shows it as applied to a vehicle.

The fore-axle is so connected to the compound brake-levers that backward pressure in descending a

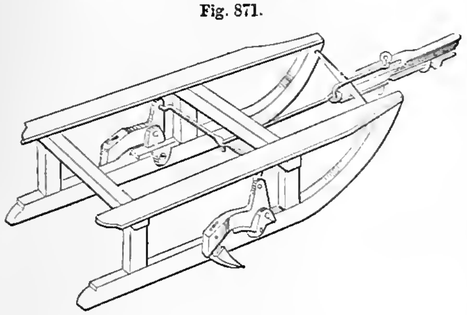
Fig. 870.



Wagon-Brake.

hill will put the brakes into action. This movement of the axle is prevented, when backing the wagon, by the pendent part of an oscillating lever upon the

Fig. 871.



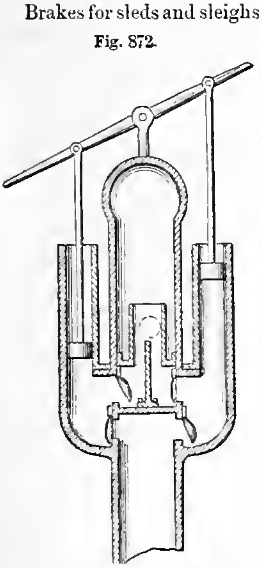
Sled-Brake.

box, which is brought in contact with the axle. See WAGON-BRAKE.

c. The part of a carriage by which it is enabled to be turned. The fore-carriage.

Brakes for sleds and sleighs consist of spurs brought into action by scraping on the ground. In the example, the brake-dogs are pivoted in a wedge-shaped mortise in one arm of a bell-crank, to whose other arm is connected a bar sliding beneath the tongue and operating by holding back on the tongue.

Fig. 872.



Pump-Brake.

4. (*Husbandry.*) *a.* A machine for separating the bark and pith from the fiber of hemp or flax; to loosen the *boon* and *shives* from the *hare.* See FLAX-BRAKE; HEMP-BRAKE.

b. An English term for a heavy harrow.

5. (*Farriery.*) *a.* A frame for confining refractory animals while being shod or undergoing operations.

b. A sharp and heavy snaffle for breaking or subduing untrained or vicious horses.

6. A name for the BALLISTA (which see).

7. (*Hydraulics.*) The extended handle of a fire-engine or similar pump, by which the power is applied. Said especially of an extended handle at which a row of men can work together.

8. (*Basket-making.*) An iron crotch with a sharp-edged reëntering angle, adapted to peel the bark from osiers drawn therethrough.

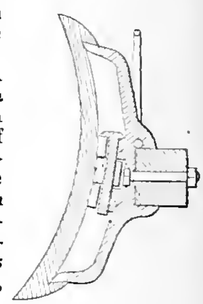
9. The baker's kneading-machine; consisting, in some cases, of a pivoted lever operating on a bench; the name now including other machinery for effecting the same purpose.

Brake-beam. (*Vehicle.*) The transverse beam connecting the shoes of opposite wheels. A *brake-bar.*

Brake-block. (*Railroad Engineering.*) The block attached to the brake-beam and holding the *shoe* or *rubber.*

Brake-shoe. That part of a brake which is brought in contact with the object whose motion is to be restrained.

Fig. 873.



Brake-Shoe.

Brake-sieve. (*Mining.*) A rectangular sieve operated by a forked lever or *brake,* from which it is suspended in a cistern of water for the agitation of comminuted ore. The meshes are of strong iron wire, ⅜ of an inch square. The brake is supported by a rolling axis. See JIGGER. The poorest light pieces are *cuttings.* Pieces of poor, sparry, heavy ore are *chats.*

Brake-wheel. 1. (*Railroad Engineering.*) The wheel on the platform or top of a car by which the brakes are operated.

2. (*Machinery.*) A wheel having cams or wipers to raise the tail of a hammer-helve.

Brak'ing. (*Flax-manufacture.*) An operation by which the straw of flax or hemp, previously *steeped* and *grassed,* is broken, so as to detach the *shives* or woody portion from the *hare* or useful fiber. See FLAX-BRAKE.

Brak'ing-ma-chine'. A machine for *braking* flax or hemp after rotting, to remove the woody portion and pith from the fiber. See FLAX-BRAKE.

Bra'mah-lock. A lock patented by Bramah, in England (1784 and 1798), having a number of slides which are adjusted in the manner of tumblers, by means of a stepped key, so that the slides of unequal length shall be brought into a position where their notches lie in the same plane, that of the locking-plate. See LOCK.

Bra'mah-press. The HYDROSTATIC PRESS (which see).

Branch. 1. (*Fortification.*) *a.* The *wing,* or long side of a horn or crown work.

b. One of the parts of a zigzag approach.

2. (*Blacksmithing.*) One of the *quarters* or *sides* of a horseshoe.

3. (*Harness.*) One of the levers attached to the ends of the stiff bit of a curb-bit, and having rings or loops for the curb-chain, the cheek-straps, and the reins. See CURB-BIT.

4. (*Mining.*) A small vein which separates from the lode, sometimes reuniting. A *leader, string,* or *rib* of ore running in a lode.

5. (*Hydraulics.*) The metallic piece on the end of a hose to which the nozzle is screwed.

6. (*Gas-fixtures.*) A gas-burner bracket.

Branch-chuck. (*Turning.*) A chuck having four branches, each of which has a set screw whose end may be made to impinge upon the object.

Brand. Paintings in the Theban tombs represent the branding of cattle on the shoulders with a hot iron, probably engraved with the owner's name.

Fig. 874.

Branding Cattle in Ancient Egypt (Thebes).

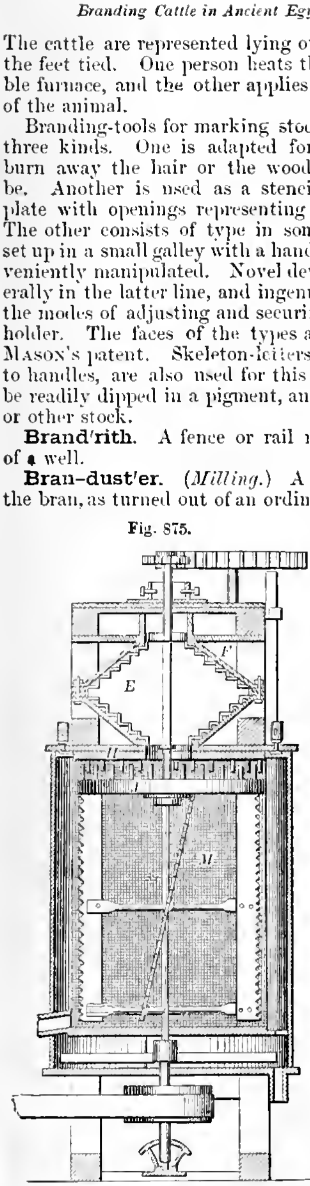
The cattle are represented lying on the ground with the feet tied. One person heats the iron in a portable furnace, and the other applies it to the shoulder of the animal.

Branding-tools for marking stock or boxes are of three kinds. One is adapted for being heated to burn away the hair or the wood, as the case may be. Another is used as a stencil, consisting of a plate with openings representing letters or device. The other consists of type in some form, generally set up in a small galley with a handle, so as to be conveniently manipulated. Novel devices are more generally in the latter line, and ingenuity is exercised in the modes of adjusting and securing the type in the holder. The faces of the types are made elastic in MASON'S patent. Skeleton-letters, secured by tangs to handles, are also used for this purpose, and may be readily dipped in a pigment, and applied to sheep or other stock.

Brand'rith. A fence or rail round the opening of a well.

Bran-dust'er. (*Milling.*) A machine in which the bran, as turned out of an ordinary bolt, is rubbed and fanned to remove as much as possible of the flour which yet adheres to it. In the example the bran passes between the radially ridged surface of the double frustum *F* and an enveloping jacket of similar form and surface. It then passes between the pin-armed head *H* of the cylinder and the head-disk *I* of a revolving frame, which carries inclined serrated plates which work the bran against the wire screen *M*. Cams of the spur-wheel above operate to agitate the screen to keep the meshes clear. The bran is finally discharged through one spout, and the other products through another.

Fig. 875.



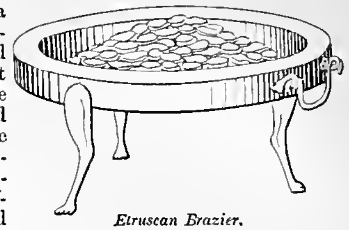
Bran-Duster.

Bran'ning. (*Dyeing.*) Preparing cloth for dyeing by steeping in a vat of sour bran-water.

Bra'sier. An open pan for burning wood or coal.

The brazier (*foculus*) of the Romans was an elegant bronze tripod, supported by satyrs and sphinxes, with a round dish above for the fire and a small vase below to hold perfumes. It occupied the *atrium*, and represented the abode of hospitality and sanctuary, even after cooking had been banished to other apartments. A kind of close stove was also used; but, in either case, the smoke was so considerable that, as luxury advanced, the winter rooms were differently furnished from those appropriated to summer use. In order to prevent the wood from smoking, the bark was peeled off, and the wood kept long in water, and then dried and anointed with oil.

Fig 876.



Etruscan Brazier.

The Greeks and other nations commonly used it, and sought to correct the deleterious nature of the fumes by burning costly odorous gums, spices, and woods.

The Japanese warming-apparatus is a chafing-dish with a handful of charcoal let into the floor, like the Spanish *brasero*. This is very ineffective in mitigating the rigor of the season in the more northerly part of the main island, and the people depend principally on clothes, heaping gown upon gown.

Brass. 1. (*Alloy.*) An alloy of copper and zinc. It is fabled to have been first accidentally formed at the burning of Corinth by Lucius Mummius, 146 B. C.; but articles of brass have been discovered in the Egyptian tombs, which prove it to have had a much greater antiquity.

Brass was known to the ancients as a more valuable kind of copper. The yellow color was considered a natural quality, and was not supposed to indicate an alloy.

Certain mines were much valued, as they yielded this *gold-colored copper*, but after a time it was found that by melting copper with a certain earth (calamine), the copper was changed in color. The nature of the change was still unsuspected.

Tubal Cain's operations in iron and brass may be held to be iron and copper (Gen. iv. 22). The translation of terms referring to metals is not perhaps very accurate. Job is made to refer to brass several times, — copper most likely.

Hiram is said to have made articles of "brass" for the Temple of Solomon, 1004 B. C. This was probably bronze, which is made by the union of copper and tin, while brass consists of copper and zinc. Hiram procured his tin in Cornwall, England. Herodotus called Britain the Cassiterides, or Tin Islands, 450 B. C. Calamine was known in early times, and the Temple utensils may have been really brass.

The "brazen" bull was cast by Perillus of Athens, for Phalaris of Agrigentum, 570 B. C. It was made hollow, to receive victims to be roasted to death. The throat was contrived to make their groans simulate the bellowing of the animal. The artist was made to furnish the first victim, and the king eventually tried the experiment in person, 549 B. C.

The helmet of Psammitichus the Powerful was of brass, and from it he poured the libation in the Temple of Vulcan, which condemned him to temporary isolation in the marshes of the Delta, but ended in his making the acquaintance of some Ionian and Carian freebooters, who assisted in placing him on the throne of Egypt, 650 B. C.

Brass was known to the Greeks as *orichalcum* or mountain-bronze. Afterwards corrupted by the Romans into *aurichalcum*, from a supposition, derived from its color, that it had gold in its composition.

Brasses (Composition of).

	Brass.	Copper.	Zinc.	Tin.	Nickel.	Lead.	Glass.	Silver.
German brass (common)	.	1	1	.	.	.	.	.
Good yellow brass	.	2	1	.	.	.	.	.
Brass wire	.	2	1	.	.	.	.	.
Muntz's sheathing-metal	.	3	2	.	.	.	.	.
Red brass, to be soldered	.	8	3	.	.	.	.	.
Common brass	.	3	1	.	.	.	.	.
Pinchbeck	.	4	1	.	.	.	.	.
Revere's sheathing-metal (1830)	.	95	5	.	.	.	.	.
Collins's red alloy for sheathing	.	8	1	.	.	.	.	.
Collins's yellow alloy for sheathing	.	10	8	.	.	.	.	.
Collins's white alloy for sheathing	.	1	16	16	.	.	.	.
Tough brass for engine work	.	20	3	3	.	.	.	.
Brass for heavy bearings	.	32	1	5	.	.	.	.
Pinchbeck	.	4	1	.	.	.	.	.
Pinchbeck	.	5	2	.	.	.	.	.
Tombac (*Malay, tambaga, copper*)	.	16	1	1	.	.	.	.
Red tombac	.	88.8	11 2	.	.	.	.	.
Red tombac	.	11	1	.	.	.	.	.
Rolled brass	.	74 3	22.3	3 4	.	.	.	.
Tutenag	.	50	31	.	19	.	.	.
Brass gilding-metal (bronze color)	.	16	1-1¼	.	.	.	.	.
Emerson's patent brass (English)	.	16	8	.	.	.	.	.
Keller's statuary brass (Versailles)	.	91 40	5.53	1 70	.	1.37	.	.
Chantrey's hard alloy	.	32	5	5	.	.	.	.
Manheim gold	.	4	1	.	.	.	.	.
Manheim gold	.	3	1	¼	.	.	.	.
Semilor	.	5	1	.	.	.	.	.
Mosaic gold (Hamilton and Parker's patent)	.	32	33	.	.	.	.	.
Mock platinum	8	.	5	.	.	.	.	.
Bath metal	32	.	9	.	.	.	.	.
White brass	.	10	80	10	.	.	.	.
Ormolu	.	48	52	.	.	.	.	.
Speculum metal (Martin's patent, August 23, 1859)	.	100	18¾	.	.	.	⅝	16
Mushet's sheathing-metal (1823)	.	100	⅛	.	.	.	.	.

The proportions are varied, and tin and antimony are added in some of the formulæ.

See also brasses and bronzes, with the addition of iron, p. 61, *ante*.

2. (*Machinery.*) In a mechanical sense a *brass* is a *pillow, bearing, collar, box*, or *bush*, supporting a gudgeon; so called from its being composed of either copper and tin or copper and zinc.

Brass-foil. Very thin beaten sheet-brass, thinner than *latten*. *Dutch-gold.*

Brass-fur'nace. Brass, or its component metals, is melted in crucibles; in the latter case, the copper being first melted, and the zinc then added piece-meal, as it is vaporized by an excess of heat.

The molding-trough *b* is on one side of the pouring or *spill-trough c*, and the furnace *a* is on the other. *d* is a core-oven, heated by the furnace, and serving to dry the cores for the faucets or other hollow articles which are cast.

The brass-furnace is usually built within a cast-iron cylinder, 20 to 24 inches in diameter, and 30 to 40 inches high, which is erected over an ash-pit, which is supplied with air through a diving-flue, which commences at a grating even with the floor of the foundry. The mouth of the furnace stands about 8 or 10 inches above the floor, and the upper aperture is closed with a plate, which is yet called the *tile*, though it is now usually of iron. A *tile* originally performed the duty. The inside of the furnace is contracted to about 10 inches by fire-bricks set in refractory clay, except a small aperture at the back, 4 or 5 inches square, which leads to the chimney.

A number of such furnaces usually stand in a row, and each communicates by its own flue with the tall stack, which carries off the volatile results of combustion, and the fumes of the zinc. Each furnace has a damper.

As a furnace burns out, so as to leave an excess of space between the crucible and the wall, the inside is renewed by plastering on a coating of road-drift and water, applied like mortar. This makes a surface, which is glazed by the fire-heat.

The workman is shown handling the *crucible-tongs*, the *reins* of which are closed by the *coupler*, while he pours the metal in at the *gate* of the *flask*, which rests in an inclined position against the *spill-trough*.

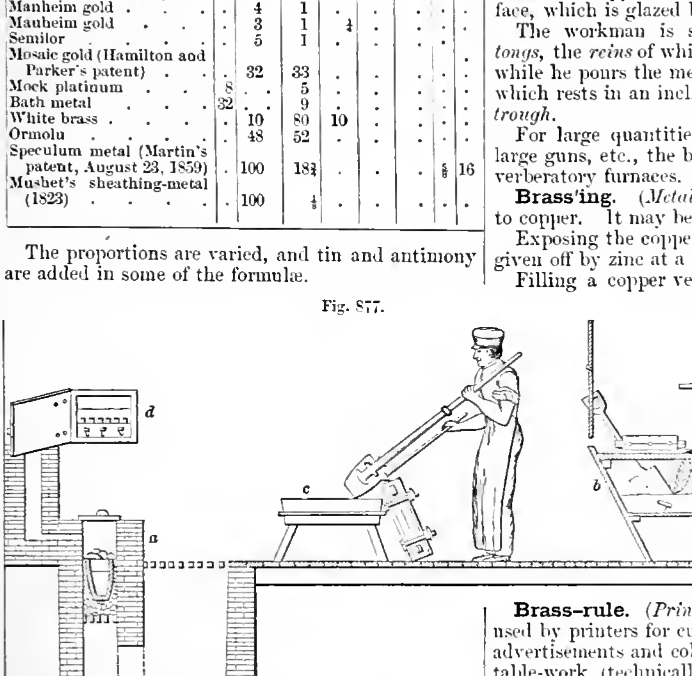
For large quantities of metal, for statues, bells, large guns, etc., the brass or bronze is melted in reverberatory furnaces.

Brass'ing. (*Metallurgy.*) Giving a brass coat to copper. It may be done by —

Exposing the copper in a heated state to the fumes given off by zinc at a high temperature;

Filling a copper vessel with water soured by hydrochloric acid, and adding an amalgam of zinc and cream of tartar, and boiling the whole for a short time.

Fig. 877.



Brass-Casting.

Brass-pow'der. (*Red-Colored.*) Grind copper filings or precipitated powder of copper with red ochre.

(*Gold-Colored.*) Gold-colored brass or Dutch leaf reduced to powder.

Mixed with pale varnish, or applied by dusting over a surface previously covered with varnish.

Brass-rule. (*Printing.*) Brass strips, type-high, used by printers for cutting into lengths to separate advertisements and columns; also for page-rules and table-work (technically known as *rule and figure* work).

They may have a single sharp edge or may be grooved to produce parallel lines.

Brat'tice. (*Mining.*) A planking on the inside of a mine shaft or gallery.

Notably, a plank-work partition in a shaft, dividing it into two portions.

Bray. (*Fortification.*) A tower or blockhouse in the outworks before the port.

Bray'er. (*Printing.*) A wooden muller used on the ink-table to temper the ink.

"Though thou bray a fool in a mortar."

Bray'ing. (*Woolen-manufacture.*) The process of pounding and washing woven cloth in *scouring-stocks,* to remove the oil applied preparatory to carding; and also soil acquired in the course of manufacture.

Braz'ing. Soldering together the surfaces of iron, copper, brass, etc., with an alloy composed of brass and zinc, sometimes with the addition of a little tin or silver. The surfaces to be united must be rendered perfectly clean and bright. The alloy, in granular form, is usually wetted with ground borax and water, dried, the pieces placed in contact and exposed to the heat of a clear forge-fire, causing the solder to flow between them. This may be assisted by the use of a soldering-iron.

Bread. A mixture of flour and water, baked to the extent of suppressing its clamminess.

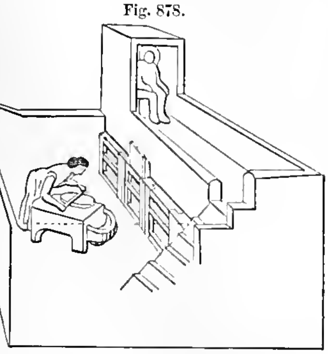
In the Old Testament we find that bread-making was a duty performed by the mistress of the family, — Sarah; by one of the daughters, — the much-abused Tamar; by servants, — as those captives referred to by Samuel, who are prospectively made to serve as "confectionaries, cooks, and bakers"; by an officer of the household, — Pharaoh's servant, the chief baker; by tradesmen, — as the bakers referred to by Hosea.

The Israelites ate leavened bread except on peculiar occasions. The Bedouin of the present day, as his ancestors did, cooks his unleavened bread in the embers, generally between layers of dung. We are not destitute of the same fuel on the Western plains, but delicately term it *bois de vache,* or, more squarely, *buffalo-chips.* When the Arab bakes a pasty bread on a pan or griddle, he calls it a *flita.* Without intending to talk Arabic, we do the same sometimes.

The Egyptian like the London bakers kneaded bread with the feet. The practice is probably more general than we know, or like to believe.

In a little model of a house found by Mr. Salt in Egypt, and now in the British Museum, a doll-woman

Fig. 878.



Bread-Making in Ancient Egypt.

stands in the court-yard in the act of rolling dough. The mixing-trough is attached at the end of the table, and the quiet little doll, which may have amused the children of the time of Moses, has maintained the position of action for near forty centuries, and is now viewed by the juveniles of a country which was alternate forest and morass for two thousand years after the little figure was started at her protracted employment.

Ching-Noung, the successor of Fohi, is reputed to have first taught the art of making bread from wheat and wine from rice, 1998 B. C. This was the era of Terah, the father of Abraham, of the shepherd kings of Egypt, and of the fabulous wars of the Titans in Greece. A few years subsequently, 1913 B. C., Melchisedek brought out wine and bread to Abram and blessed him (Gen. xiv. 18). Fifteen years afterward we find Abraham giving three strangers a morsel of bread to stay their stomachs, while his wife prepared hot cakes made out of fine meal, kneaded, and no doubt cooked in the ashes, as they had not then seen the Egyptian plan of cooking in ovens. This was served up with butter, — probably bonny-clabber or curds, — milk, and veal.

The Hebrew bread was a flat cake, baked on the hearth or on a metallic plate. It was broken, not cut, and may have had indentations to form lines of easy fracture. Thus may have arisen Paul's remark, —"We, being *many,* are *one bread*" (1 Cor. x. 17).

In the time of Pliny we find that, though bread was made from a variety of grains, yet that wheat was held in the highest estimation: the wheat of Italy ranking first for weight and whiteness, while that of Sicily, one of the granaries of Rome, stood third, Bœotian wheat being preferred to it.

He states that the weight of all commissary bread exceeded that of the flour from which it was made by one third, and this is still held to be the proper percentage of gain in well-made bread from good flour. The German proportion, stated by Köhler in his *Rechenmeister,* is 156 pounds of dough, and 153 pounds 11½ ounces of bread from 100 pounds of flour.

The Romans appear to have leavened their bread with preparations similar to that known in some places as "salt rising," instead of yeast. Pliny says that in Gaul and Spain, where they make a drink (beer) by steeping grain in water, they employ the foam which thickens on the surface (yeast) as a leaven, and that consequently the bread in those countries is lighter than that made elsewhere. He must mean in proportion to its bulk, and not that a certain quantity of flour would produce a less weight of bread.

The Roman leaven is described as being made from millet mixed with grape-juice, which it is said would keep a whole year. Fine wheat bran was also employed; this was mixed with white must (or grape-juice) three days old, then dried in the sun and made into small cakes. For making bread, these cakes were first soaked in water boiled with the finest spelt-flour, and then mixed with the dough.

These kinds of leaven could only be made during the vintage, but there was another kind, made from barley and water, which could be prepared at any time; this was made up in cakes of two pounds' weight, which were baked until they became of a reddish-brown color, when they were put in close vessels and allowed to turn sour; when wanted for leaven, they were steeped in water.

Leaven, for immediate use, was also prepared by kneading some of the flour, without salt, boiling it to the consistency of porridge, and keeping it till it began to turn sour; or the bread was leavened by means of some of the dough left over purposely from the day before, as among the ancient Hebrews.

In the maritime districts the flour was mixed with sea-water, to economize salt; and in the preparation of some kinds of flour, according to Pliny, the bran was first taken off the berry by trituration in mortars containing brickbats and sand. His translators have rather absurdly made him say that bricks and sand were ground up with the grain. In one species of bread, called *alica*, which he mentions as being peculiarly wholesome and palatable, a species of chalk found in the hill Leucorgeum, between Naples and Puteoli, was employed for imparting whiteness and crispness.

Their bread was probably too moist for our taste, rather a pasty mass, somewhat better than the common *puls*, which resembled our paste or gruel, a sort of hasty-pudding, and which formed the staple of the farinaceous diet of the Romans.

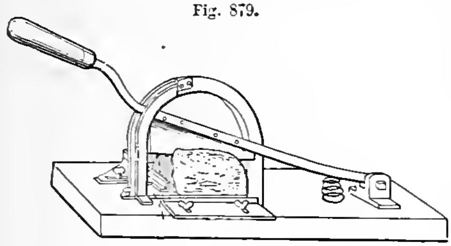
There were no professional bakers in Rome till after the war with King Perseus, more than 580 years after the building of the city. The occupation formerly belonged to the women. They ate their bread moist; it was sometimes kneaded with the must of the grape, with raisin-juice, or with butter for shortening, or with eggs and milk, and often soaked in milk and honey before eating. Vinegar, to soak the bread, was a regular ration with the Roman soldiery. It is much older than that, however: Boaz said unto Ruth, "Eat of thy bread, and dip thy morsel in the vinegar."

After the conquest of Macedon, 148 B. C., Greek bakers came to Rome and monopolized the business. Loaves of bread, or their pseudomorphs, are found in the excavations of Pompeii, partially buried A. D. 79.

Bread was made with yeast by the English bakers in 1634. Was made by machinery in England in 1858. Was artificially inflated with carbonic-acid gas, with which the water of mixing was impregnated, by Dr. Dauglish, in 1859. Aërated bread was made in the United States prior to 1854.

Bread-knife. A knife pivoted at one end to a post on a table, and used by a vertical motion to cut loaves into slices. In the example the hinged cut-

Fig. 879.



Bread-Knife.

ter plays in a slotted arched frame; an adjustable guide is adapted to the size of the loaf, and a gage determines the thickness of the slice to be cut.

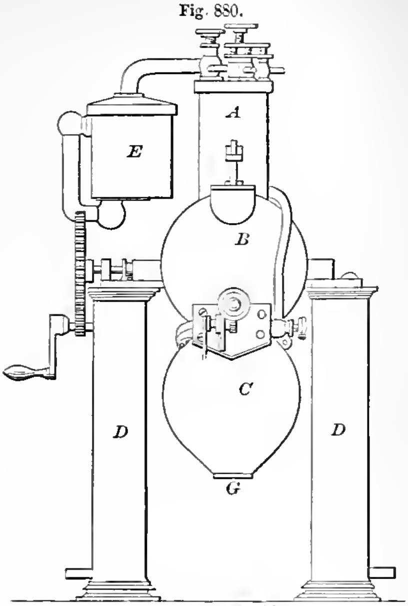
Bread-mak'ing Ma-chine'. A machine in which flour and water are mixed and kneaded. In some machines of this character the dough is rolled flat and cut into loaves, which are laid aside to rise before baking. See BREAD.

The process of making bread without leaven or yeast, generally known as aërated bread, is believed to have been first practiced with any considerable degree of success in the United States some twenty years ago. In England it appears to have been of later introduction, the process of Dr. Dauglish having first been made public in 1859. It consists in generating carbonic-acid gas in a separate vessel and mechanically forcing it into the water with which the flour is mixed.

His apparatus for making aërated bread is shown in the illustration.

The water-chamber *A* and mixer *B* are cast in one piece, and communicate by an equilibrium pipe and

Fig. 880.



Bread-Making Machine.

valved aperture; the water-chamber also communicates with a water-tank and with the gas-generating chamber *E* through pipes whose discharge is controlled by cocks operated by hand-wheels. The flour and salt are placed in the mixing-chamber *B*, and water is admitted to the water-chamber from the tank. When the gas in its chamber has attained a sufficient degree of pressure, say 100 pounds to the square inch, the cock leading to the water-chamber is turned, and the gas passes through the water, which thus becomes thoroughly charged under that high pressure, and is then admitted to the mixing-chamber, where it is mingled with the flour and salt by means of revolving mixers on a shaft rotated by gearing driven by hand-crank or a steam-engine. The receiver is secured to the mixing-chamber *B* by a bolted flange, and communicates with it through an aperture provided with a slide-valve, which is capable of a rotary as well as a reciprocating motion, by means of which any dough can be pressed out from between it and its seat. The two vessels are also connected by an equilibrium-pipe, that the pressure of gas may be equal in each, allowing the dough to fall into the mixing-chamber by its own gravity. From the receiver the dough is passed to the baking-pan, by means which allow of its being surrounded by air or gas under pressure, thus lessening the escape of the gas inclosed in the dough.

The baking requires to be conducted in a peculiar manner. Cold water being used in mixing, the expansion of the dough on rising causes a great reduction of temperature, as much as 40° below that of fermented bread when placed in the oven; this, with its slow springing until it reaches the temperature of the boiling-point, renders it essential that the top crust should not be formed until the very close of the process. The furnaces, accordingly, are so arranged that the heat is applied through the bottom;

and, at the last moment, when the bread is nearly baked through, the upper heat is applied and the top crust formed.

The principles of bread making and baking have been carefully explained by Professor Horsford, of Cambridge, Mass.

Bread-rasp. A *rasp* used by bakers in removing the burned crust of loaves and rolls, especially of French rolls.

Bread-slic'er. See BREAD-KNIFE.

Breadth. (*Shipwrighting.*) The thwart measure of a ship at any designated place. The *beam* is the *extreme breadth;* that is, at the widest part.

Breadth-line. (*Shipwrighting.*) A line of the ship lengthwise, following the curve indicated by the ends of the timbers.

Break. 1. A wooden bench on which dough is kneaded by means of a lever called a *break-staff*. The weight of the person, often in a sitting posture, is thrown upon the staff, which moves in a semicircular orbit around the bench, keeping up a saltatory motion by its flexibility and the dancing action of the operator. By this means the dough is worked up very dry, and makes the best kind of crackers.

This duty is now performed by rollers, which receive their name from their duty, being called *breaking-rollers.*

2. (*Fortification.*) A change from the general direction of the *curtain* near its extremity in the construction with orillons and retired flanks. *Brisure.*

3. (*Printing.*) The piece of metal contiguous to the shank of a type, so called because it is broken off in finishing.

4. (*Architecture.*) A projection or recess from the surface or wall of a building.

5. A sudden change of level, as of a deck. The *break* of a poop-deck is where it ends forward.

6. (*Telegraphy.*) A commutator or apparatus to interrupt or change the direction of electric currents.

See BRAKE, for devices for applying power, for restraining motion, etc.

Break'er. 1. (*Nautical.*) A small cask for ship's use. Employed for bringing water aboard in boats, or for containing the water required for a boat's crew absent from the vessel on duty.

The *gang*-cask is kept on deck, and contains the drinking-water for the ship's company, being replenished from day to day from the tanks.

2. (*Flax-manufacture.*) The first carding-machine which operates upon the parcels of tow from a creeping-sheet. The *finisher* is the final carding-machine, and operates upon a *lap* formed of *slivers* of *line.*

Break-ground. (*Fortification.*) To open the trenches or begin the works of the siege.

Break'ing. (*Woolen-manufacture.*) A process in the worsted or long-wool manufacture. The combed slivers are laid upon a traveling-apron and joined endwise, to make continuous lengths.

Break'ing-down Roll'ers. (*Metal-working.*) Rollers used to consolidate metal by rolling it while hot.

Break'ing-en'gine. The first of a series of carding-machines, to receive and act on the lap from the lapper; it has usually coarser clothing than the finishing-cards. See CARDING-MACHINE.

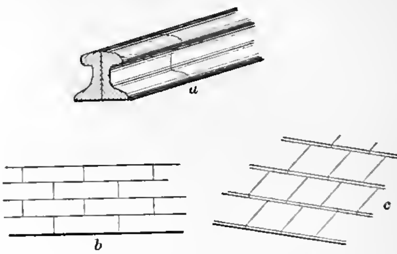
Break'ing-frame. (*Worsted-manufacture.*) A machine in which *slivers* of long-stapled wool are *planked* or spliced together and then drawn out to, say, eight times their original length. The *slivers* are made by hand-combs, and taper towards each end. Each is laid lapping half its length upon the preceding sliver, and the passage between rollers of gradually increasing speed attenuates the sliver.

Break'ing-ma-chine. (*Flax-manufacture.*) A machine for shortening flax-staple, to adapt it to be worked by a certain kind of machinery. *Long-flax* or *long-line* becomes *cut-flax* or *cut-line.* The machine is also known as a *cutting-machine* or *flax-breaker.*

Break-i'ron. (*Carpentry.*) The iron screwed on top of a plane-bit to bend upward and *break* the shaving. Its edge is from $\frac{1}{16}$ to $\frac{1}{30}$ of an inch from the edge of the cutting-bit.

Break-joint. A *break-joint* structure is one in which the joints of the parts or courses are made to

Fig. 881.



Break-Joint Rail and Courses.

alternate with unbroken surfaces, as in the continuous railroad rail, in bricklaying, shingling, and numerous other mechanic arts.

a, break-joint of a compound rail.
b, break-joint of bricks in courses.
c, break-joint of slates in courses on a roof.

Break'wa-ter. A structure or contrivance, as a mound, mole, wall, or sunken hulk, interposed to break the force of the waves and to protect an anchorage, harbor, or any object exposed to the waves.

Breakwaters for the purpose of protecting harbors are of very ancient origin.

The harbor of Alexandria was protected by a stone mole called the Heptastadium, which joined the island of Pharos and the main-land. It had two passages through it, which were spanned by bridges.

Nebuchadnezzar built quays and breakwaters along the shores of the Persian Gulf. — HERODOTUS.

The harbor of Rhodes and the Piræus of Athens were protected by moles, as were also those of Civita Vecchia, Ostia, Antium Misenus, and others among the Romans.

We are informed by Josephus, that Herod, desiring to form a port on the coast of Syria, between Joppa and Dora, caused great stones, most of them 50 feet long by 10 wide and 9 deep, and some even larger, to be cast into the sea in 20 fathoms of water, with a view of forming a foundation for a mole or breakwater.

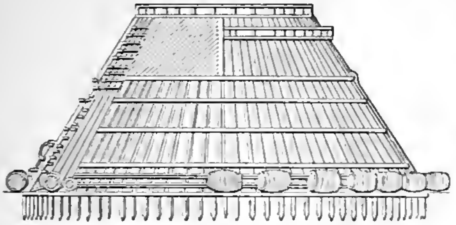
The Romans constructed the moles or breakwaters of many of their harbors upon a double row of arches, so arranged that the openings of one set were opposite the piers of the other, by which means the force of the waves was thoroughly broken, while still permitting the passage of the current, thus greatly reducing the accumulation of deposits around the base of the structure, and consequent tendency towards filling up the harbor. The piers of the new river-frontage of New York are to be constructed on pillars which allow free course to the water, being intended for wharfage, not wave-breakers.

The breakwater of Cherbourg was commenced in 1784. Its total length is 4,120 yards, consisting of two arms, respectively 2,441 and 1,679 yards long, forming an obtuse angle of 169° towards the sea. The average depth of water inclosed is 62 feet at high spring-tides, and the area sheltered is about

1,927 acres, about one third of which has a depth exceeding 27 feet at low-water spring-tides.

Cessart's plan for breakwaters at the latter part of the last century consisted of large truncated cones of timber floated by means of air-barrels lashed thereto, and towed to the spot. These were 150 feet in diameter at the bottom, 64 at the top, and

Fig. 882.



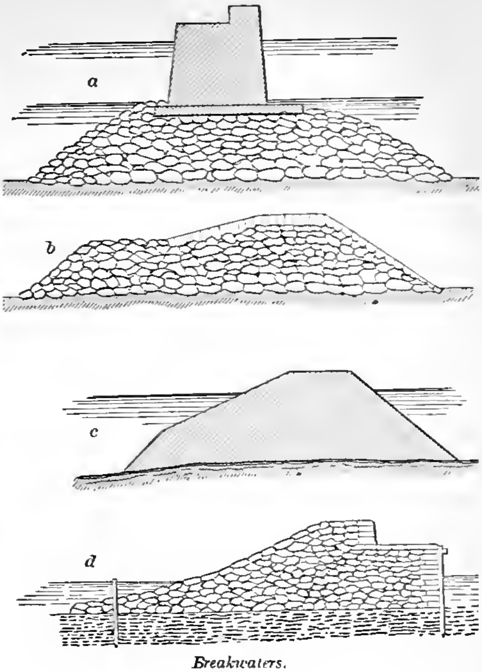
Cessart's Breakwater.

70 feet high. Ninety such cones were to be placed consecutively, to form a breakwater when sunk and filled in with stone. The project was only partially carried out. The timbers were dislocated and the stones scattered. The work was renewed by additions of stone till it reached the level of low-water spring-tides; upon these was laid a bed of hydraulic concrete five feet thick, and upon this was erected a solid wall of coursed ashlar masonry faced with granite. The top of the sea-slope is covered with large loose blocks, and at the extremities of the wings it is farther protected by immense artificial blocks, weighing about 40 tons each, formed of rubble set in hydraulic cement. Fig. 883 (*a*) shows a section of this work.

b is a section of the breakwater off Plymouth, England, to protect the harbor, which is only open to the south. It is situated upon the inner of three natural reefs of rock, which lay outside the harbor, and closes what was once a central passage, leaving open passages to the east and west. The main body is placed perpendicularly to the S.S.E., and is 1,000 yards long. Wings at each end form angles of 135°, and are each 350 yards in length. A surface of 1,120 acres is protected. It is 133 yards wide at bottom, 15 at top; a set-off 22 yards wide forms a foreshore on the sea side. The upper portion is revetted with masonry laid in Roman cement on both faces and crown. The hight of the latter is 2 feet above high-water spring-tides. 4,105,920 tons of stone were used in the construction. Cost, $ 7,500,000.

Delaware Breakwater is situated just inside of Cape Henlopen, the southwestern point of land at the entrance of Delaware Bay, and was intended to form a harbor of refuge during storms for vessels passing along the coast. The work was commenced in 1829. It consists of two parts, the breakwater proper and the ice-breaker. The former is 1,203 yards long, extending in an E.S.E. and W.N.W. direction. The ice-breaker is designed to protect the harbor from floating ice brought down by the Delaware River, is 500 yards long, and lies in an E. by N. and W. by S. direction, having a passage of 350 yards between it and the breakwater, the prolongation of which would pass near the center of the ice-breaker. The work protects from the more dangerous winds an area of about 420 acres, having a depth of 3 to 6 fathoms, leaving a passage of about 1,000 yards in length between the shore and its landward extremity.

Fig. 883.



Breakwaters.

The width of the structure is 175 feet at base and 30 feet at top, and it is composed of rough blocks of stone. A transverse section is shown at *c*, Fig. 882. The inner slope has an angle of 45°, the outer slope has an inclination of 3 base to 1 of hight to a depth of about 19 feet below the highest spring-tides, and from thence to the bottom of 45°.

Breakwaters have also been constructed by the United States government at several lake-ports, particularly at Buffalo and Cleveland on Lake Erie, and Chicago on Lake Michigan.

The covering pier or breakwater of Buffalo Harbor (*d*, Fig. 883) is built of stone, and cost about $ 200,000. The illustration shows a cross-section. It measures 1,452 feet in length. The top of the pier on which the roadway is formed measures eighteen feet in breadth, and is elevated about five feet above the level of the water in the harbor. On the side of the roadway which is exposed to the lake, a parapet-wall, five feet in hight, extends along the whole length of the pier, from the top of which a talus wall, battering at the rate of one perpendicular to three horizontal, slopes towards the lake. This sloping wall is formed of coursed pitching. Its foundations are secured by a double row of strong sheeting-piles driven into the bed of the lake, and a mass of rubble *pierres perdues*, resting on the toe of the slope. The quay or inner side of the pier is perpendicular, and is sheathed with a row of sheeting-piles, driven at intervals of about five feet apart from center to center, to prevent the wall from being damaged by vessels coming alongside of it.

The harbor of the city of Pernambuco, in Brazil, is defended by a natural breakwater, — a reef of hard coral just level with the sea, and extending for miles along the coast, parallel with the main-land and but a very short distance from it, leaving a narrow channel of sufficient depth to float vessels of considerable size between them.

Here ships may ride in perfect safety, the water being as smooth as a mill-pond, while the sea is breaking furiously upon the reef, even at times casting its spray on the decks of vessels moored inside.

Break'wa-ter-gla'cis. (*Hydraulic Engineering.*) A *storm pavement.* The sloping stone paving next the sea in piers or breakwaters.

Bream'ing. (*Nautical.*) Cleansing the ooze, shells, seaweed, etc., from the bottom of a ship by a flashing fire and scraping.

Breast. 1. (*Agriculture.*) The forward part of a plow's mold-board.

2. (*Carpentry.*) The lower side of a hand-rail, a rafter, the rib of a dome or of a beam.

3. (*Mining.*) The face of a coal-working.

4. (*Architecture.*) *a.* That portion of a wall between the window and the floor.

b. That portion of a chimney between the flues and the apartment.

5. (*Machinery.*) A bush connected with a small shaft or spindle.

6. (*Hydraulics.*) The curved wall up to which the floats of a water-wheel work, and which prevents, as far as possible, the waste of water.

7. (*Sheet-iron Ware.*) As applied to milk-cans, coffee and tea pots, and similar articles, this word denotes the bulging or rounded top which intervenes between the lid or cover and the cylindrical portion which forms the body of the vessel.

8. (*Vehicle.*) The *middle, swell,* or *bulge* of a nave or hub.

9. The front of a furnace.

10. The part of an object against which the breast pushes in some machines, such as the *breast*-drill, *breast*-plow, etc.

Breast-band. (*Saddlery.*) A band passing across the breast of the draft animal, and to which the traces or tugs are attached. It is a substitute for a collar.

Breast-beam. 1. (*Shipwrighting.*) A beam at the break of a quarter-deck or forecastle.

2. (*Weaving.*) The cloth-beam of a loom.

3. (*Railroad Engineering.*) The forward transverse beam of a locomotive.

Breast-board. (*Rope-making.*) A loaded sled to which are attached the end yarns at the foot of the walk. As the yarns are twisted into a strand they become shorter and draw the sled towards the head of the walk, the load on the sled maintaining the necessary tension. The yarns are usually shortened one third by the twisting, and lose about thirty per cent in so doing. The twist is, however, necessary, to give the requisite rigidity, to prevent the fibers sliding on each other, and to partially exclude wet. The addition of tar increases the power of excluding water.

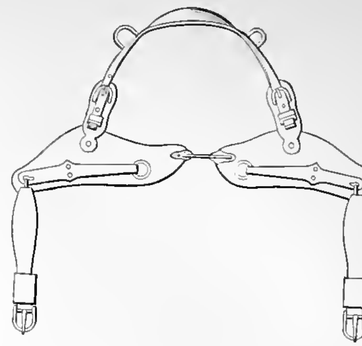
Rope not twisted, but bound tightly together, is stronger than twisted rope, but is soft and not durable, the yarns readily admitting water, which rots the rope.

Breast-chain. (*Saddlery.*) A chain reaching between the hame-rings, its loop passing through the ring of the neck-yoke, to support the tongue.

In carriage harness, the hame is destitute of the rings, and the strap is passed around the lower part of the collar. See NECK-YOKE.

Breast-col'lar. (*Harness.*) A pulling strap which passes around the breast of the horse; a substitute for a collar, which encircles the neck and rests against the shoulders. In the example the breast-strap is padded, and the two pieces are connected by a snap. A plate upon it holds the breast-rings and tug-buckle pieces.

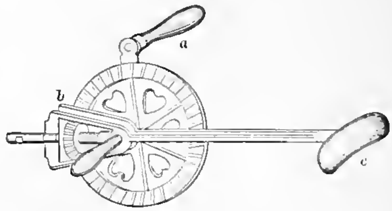
Fig. 884.



Breast-Collar.

Breast-drill. (*Metal-working.*) A drill-stock operated by a crank *a*, and bevel gearing *b*, and hav-

Fig. 885.



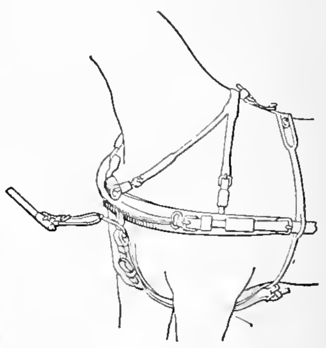
Breast-Drill.

ing a piece *c* against which the workman bears his breast when engaged in drilling.

Breast-fast. (*Nautical.*) A mooring hawser to confine the ship's broadside to a quay or wharf. *Bow* or *head fast* and *stern-fast* indicate ropes of different positions but similar duty.

Breast-har'ness. (*Saddlery.*) A horse-gear arranged to pull by a band in front of the breast, instead of a collar.

Fig. 886.



Breast-Harness.

Breast-hight. (*Fortification.*) The interior slope of a parapet.

Breast-hook. (*Shipbuilding.*) One of the curved horizontal timbers placed inside the bow as *struts* to support and *ties* to connect the sides. Also called *breast-knee.*

Breast'ing.

1. (*Mill.*) The curved masonry against which the shuttle side of a breast-wheel works, and which prevents the water from slipping past the wheel.

The scoop-wheel has also a *breasting* which confines the water raised thereby. See SCOOP-WHEEL.

2. (*Paper-making.*) The concave bed against which the wheel of a rag-engine works; between the two is the *throat.* See RAG-ENGINE.

Breast-line. The rope connecting the pontons of a military bridge in a straight direction.

Breast-mold'ings. (*Carpentry.*) Window-sill moldings. Panel moldings beneath a window.

Breast-plate. 1. A plate which receives the hinder end of a drill, and by which pressure is applied. Formerly held against the breast, it still retains its name, even when otherwise supported. A *conscience* or *palette*. See BREAST-DRILL.

2. Armor for the breast. The forward portion of a cuirass.

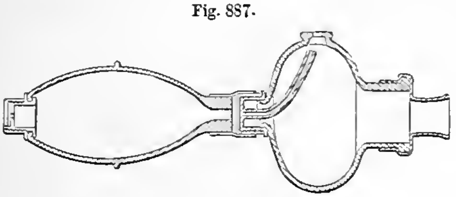
Breast-plow. (*Husbandry.*) A shovel whose handle has a cross-piece applied to the breast, and used for paring turf or sods.

Breast-pump. (*Surgical.*) Also known as *antlia lactea* or *antlia mammaria.*

A pump having a cup adapted to fit over the nipple, in order to withdraw milk from the *mamma* when this cannot be effected in a natural way.

In one example the receiver has an opening which in use is covered by the thumb and serves as an exit for the milk. The air is drawn off through an up-

Fig. 887.

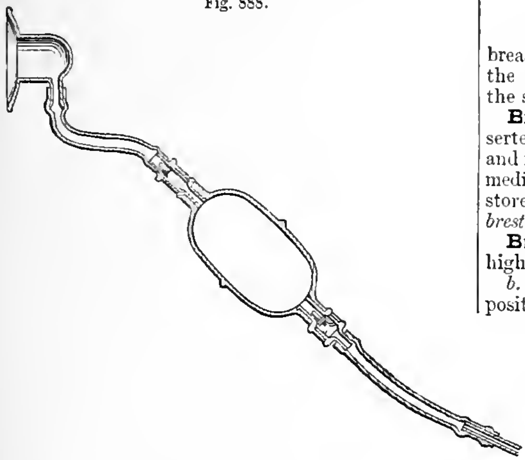


Breast-Pump.

turned tube, which prevents the access of liquid to the valves. The valves consist of two cylindrical flanged caps, whose ends are perforated and inclose between them a valve-disk of rubber.

In the other example the suction-nipple is of rigid material, and has side discharge into the flexible pipe

Fig. 888.



Breast-Pump.

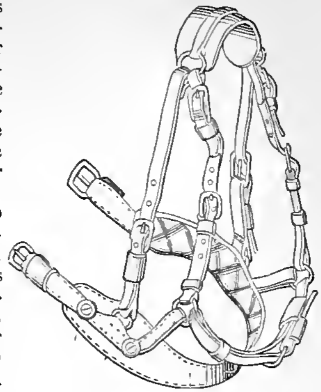
communicating with the elastic bulb. The latter has induction and eduction valves.

Breast-rail. (*Shipwrighting.*) The upper rail of a balcony or of a breastwork on the quarter-deck.

Breast-strap. (*Saddlery.*) A strap passing from the *hame-rings* or from the *gullet* of the collar, to support the tongue or pole of the vehicle.

Breast-strap Har'ness. (*Saddlery.*) That which has a strap around the breast instead of a collar. In the example the breast-collar is supported as usual from the withers, and at its rear ends receives the tug-straps. Other forward attachments are made to the breast-straps, which are connected to the neck-yoke or tongue.

Fig. 889.

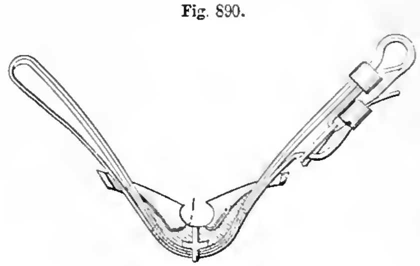


Breast-Strap Harness.

Breast-strap Slide. (*Harness.*) An iron loop which slips on the breast-strap, and takes from the latter the wear of the ring on the end of the neck-yoke. The ends of the breast-strap are passed through the rings on the harness.

A detachable tongue or pin, made with a double point and a flange at the center, engages with the

Fig. 890.



Breast-Strap Slide.

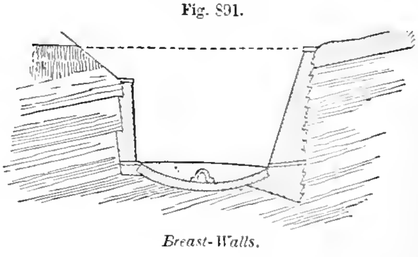
breast-strap when the slide is to be held fixedly on the strap, and is removed when it is desired that the slide should yield or play on the breast-strap.

Breast-sum'mer. (*Carpentry.*) A beam inserted flush with the house front which it supports, and resting at its ends upon the walls and at intermediate points upon pillars or columns. Common in store fronts. Written also (incorrectly) *bres-summer, brest-summer.*

Breast-wall. (*Masonry.*) *a.* One built breast-high.

b. A wall erected to maintain a bank of earth in position, as in a railroad cutting, a sunk fence, etc.

Fig. 891.



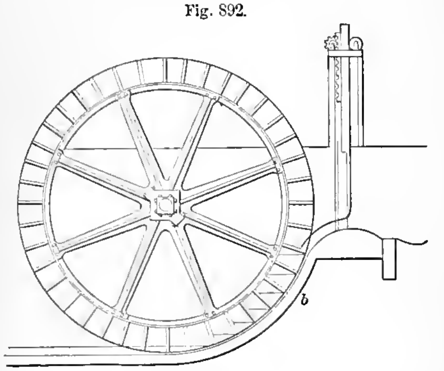
Breast-Walls.

The thickness and batter of the breast-wall depend upon the character and inclination of the strata. It is held to be a safe rule to make the base of the wall not less than one fourth, and the *batter* not less than one sixth, of the vertical hight of the wall.

Where the strata are horizontal, a mere casing may be sufficient, but its strength must be considerably increased when the strata incline towards the wall. The thickness required will also depend upon considerations of the cohesion of the earth, dryness, or tendency to moisture, drainage, and the peculiar superposition and dip of strata indicating land-slips.

Breast-wheel. A wheel to which the water is admitted about on a level with the axle, and maintained in contact with it by a *breasting* (*b*), or casing, which incloses from 60 to 90° of the periphery of the wheel. The wheel may have radial or hollow buckets.

Fig. 892.



Breast-Wheel.

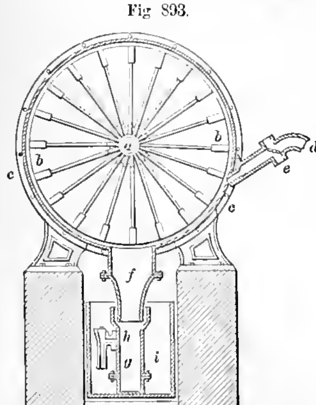
The peripheral inclosure is sometimes called *breasting*, or *soleing*, and the casing at the ends of the wheel is called *shrouding*.

Breast-wheel Steam-en'gine. A form of *rotary steam-engine* in which a jet of steam is made to impinge upon the floats of a wheel rotating in an air-tight case.

The first steam-engine of this class was one of the earliest on record. Brancas, A. D. 1520, had a copper boiler and eduction-pipe, the steam issuing from which rotated the vanes of a shaft, which (*on dit*) worked pestles for grinding materials, raising water by buckets, sawing timber, etc.

Corder and Locke's *breast-wheel engine* is one form of the rotary steam-engine, having neither piston nor valves. It consists of a wheel rotating in an air-tight case, receiving a jet of steam introduced in a tangential direction, the case having free communication with a condenser. The action upon the wheel is analogous to that of water upon a breast-wheel, the steam impinging with a force determined by its pressure and with an effect proportionate to the size of the float or bucket upon which it acts.

Fig 893.



Corder and Locke's Rotary Steam-Engine.

The action of the condenser is auxiliary; making a partial vacuum in the case, increasing the absolute pressure of the steam, which passes in to fil the void. The shaft of the wheel passes through stuffing-boxes at the center of the circular case, and is supported externally by bearings.

a is the engine-shaft.
b, the revolving wheel.
c, the air-tight steam-case.
d, the steam-pipe.
e, the throttle-valve.
f, the eduction-pipe.
g, the condenser.
h, the injection-cock.
i, the cold-water cistern.

The condensing apparatus has the usual pumps, not shown in the cut.

Breast'work. 1. (*Fortification.*) A hastily constructed parapet made of material at hand, such as earth, logs, rails, timber, and designed to protect troops from the fire of an enemy.

2. (*Shipbuilding.*) A railing or balustrade standathwartships across a deck, as on the forward end of the quarter-deck or round-house.

The beam supporting it is a *breast-beam.*

3. The parapet of a building.

Brec'cia. (*Masonry.*) A kind of marble composed of a mass of angular fragments, closely cemented together in such a manner that when broken they form *brèches* or notches.

Breech. 1. (*Fire-arms and Ordnance.*) The rear portion of a gun; the portion behind the chamber.

2. (*Shipbuilding.*) The outer angle of a knee-timber; the inner angle is the *throat.*

Breech-block. A movable piece at the breech of a breech-loading gun, which is withdrawn for the insertion of a cartridge and closed before firing, to receive the impact of the recoil. This is the great problem in the breech-loading gun. Under Fire-arm the subject is treated, the invention being divided into 2 genera, 91 species, and 21 varieties, according to the mode of moving the block relatively to the barrel or the barrel to the block. The problem is to open the rear of the barrel and close it again. See Fire-arm.

Breech'ing. 1. (*Ordnance.*) A rope secured by a thimble to the breeching-loop of a ship's gun, and attached by its ends to ring-bolts on each side of the port-hole, serving to limit the recoil of the gun when fired.

The *breeching-loop* occupies the place of the ordinary *cascabel.*

2. (*Harness.*) The portion which comes behind the buttocks of a horse, and enables him to hold back the vehicle in descending a hill.

3. A bifurcated smoke-pipe of a furnace or heater.

Breech'ing-hook. (*Vehicle.*) A loop or hook on the shaft of a carriage for the attachment of the strap of the breeching, by which the horse bears backwardly against the load in descending a hill.

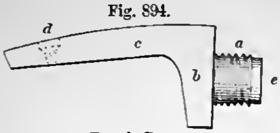
Breech'ing-loop. The loop of the cascabel in ships' guns, through which the breeching goes to prevent the recoil.

Breech-load'er. A fire-arm in which the load is introduced at the rear instead of at the muzzle. The use of breech-loaders goes back to the sixteenth century; indeed, it is probable that that form of arm is about as old as the muzzle-loader. See Fire-arm; Revolver; Magazine-gun; Cannon. See also list under Weapons.

Breech-pin. (*Fire-arms.*) A plug screwed into the rear end of a barrel, forming the bottom of the charge-chamber. Otherwise called a *breech-plug* or *breech-screw.*

Breech-screw. (*Fire-arms.*) The plug which closes the rear end of the bore of a fire-arm barrel. The parts are known as

Fig. 894.



Breech-Screw.

a, plug.
e, face.
b, tenon.
c, tang.
d, tang-screw hole.

Breech-sight. (*Fire-arms.*) The hinder sight of a gun. In conjunction with the front sight it serves to aim the gun at an object. It is graduated to degrees and fractions, their length on the scale being equal to the tangents of an arc having a radius equal to the distance between the front and rear sights. The front sight is merely a short piece of metal screwed into the gun, usually at the muzzle, but sometimes between the trunnions, or on one of the rimbases, with its upper edge parallel to the bore of the gun. The rear sight may be detached, having a circular base fitting the base of the gun, or may slide through a slotted lug, and be retained at any given hight by a set screw.

The *breech-sight*, the *tangent scale*, and the *pendulum* are merely different forms of this device, the latter having a bulb at its bottom which keeps it in a vertical position when the two wheels of the carriage are not at the same level. It is suspended in a seat which is screwed into the breech of the gun. The tangent scale has steps, corresponding in hight to the graduations on the breech sight for guns of the same caliber and pattern; and is only applied to the gun at the moment of sighting. See BACK-SIGHT.

Breech-wrench. A wrench used in turning out the breech-pin of a fire-arm.

Breeze. (*Brick-making.*) Refuse cinders used for burning bricks in the clamp.

Breeze-ov'en. A furnace adapted for burning coal-dust or *breeze*.

Bre-luche'. (*Fabric.*) A French floor-cloth of linen and worsted.

Bre-quet'-chain. A chain for securing the watch in the vest pocket to a button or button-hole of the vest.

Bres'-sum-mer. (*Carpentry.*) A girder in an external wall, supported by piers or pillars, and carrying a superincumbent weight. Sometimes written *brest-summer;* properly, *breast-summer*.

Brett. (*Vehicle.*) A four-wheeled carriage having a calash top and seats for four besides the driver's seat. A short term for *britzska*.

Bret'tice. (*Mining.*) *a.* A vertical wall of separation in a mining-shaft which permits ascending and descending currents to traverse the respective compartments, or permits one to be an upcast or downcast shaft, and the other a hoisting shaft; otherwise written *brattice*.

b. A boarding in a mine, supporting a wall or roof.

Breve. (*Printing.*) A curved mark ("◡") indicating the short quantity of a vowel; as, — Ĕp'i-grăm.

(*Music.*) A note in music ("𝅜") of the value of four minims.

Bre-vier'. (*Printing.*) A size of type between bourgeois and minion.

Bourgeois, 102 ems to the foot.
Brevier, 112 ems to the foot.
Minion, 128 ems to the foot.

Brew'ing. The art of preparing fermented liquors from grain. Herodotus, who wrote about 450 B. C., says that the Egyptians made their "wine" from barley, and ascribes the invention to Isis, wife of Osiris. The Greeks used a malt liquor under the name of barley wine, having learned the art of making it from the Egyptians. It is mentioned by Xenophon, 401 B. C. According to Tacitus, beer was a common drink among the Germans, and Pliny says that in his time all the nations of the West of Europe made an intoxicating liquor from grain and water. The description given by Isidorus and Orosius of the manner of its preparation in Britain and other ancient Celtic countries, applies precisely at the present day, so far as the infusion of malt is concerned, but no mention is made of the use of hops. These do not appear to have been used by the Greeks, Romans, or early Germans, though the plant grows wild in Europe. It is first mentioned in a letter of Pepin (A. D. 752), who speaks of *humulonariæ* (hop-gardens). It is again referred to by Adelard, Archbishop of Larby, 822.

Hops, pressed into masses like bricks, have been placed by the Chinese in their beer from time immemorial. The same custom is, or was, practiced in Bohemia. They were introduced into England by a native of Artois about the beginning of the fifteenth century, but their use was opposed by physicians from the supposition that they made the beer unwholesome. The cultivation was forbidden by acts of Henry VI. and Henry VIII., but eventually survived this injurious legislation.

The manufacture of beer must have been carried on to a considerable extent among the Anglo-Saxons, as ale is mentioned in the laws of Ina, king of Wessex, and at after periods.

Malting is the first step in the process of making fermented liquors from grain, and for this any of the cereals, such as wheat, oats, buckwheat, rice, or Indian corn, may be employed, but the preference has been universally given to barley.

The barley is steeped, to saturate and swell the grain, laid in piles to germinate, being spread and turned to allow access of air; when the stem or *acrospire* has nearly reached the end of the kernel, the germination is stopped by heating the malt in a kiln. The roots fall off in the drying and screening.

The malt is coarsely ground and mashed; water, at a heat of 160° or 170°, dissolving the sugar developed by the malting, and allowing the diastase to act upon any remaining starch which has continued unchanged. Water at 194° is added to complete the infusion, and the *wort* is drawn off. Successive amounts of water remove remaining soluble matter. A saccharometer is used to test the strength of the infusion, which is then boiled with hops in a copper boiler. It is then strained, cooled, yeast added, allowed to ferment, transferred to storage-vats, or drawn off at once into barrels.

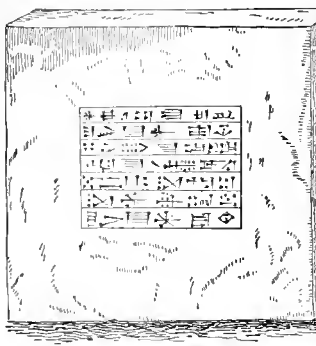
Brew-ket'tle. (*Brewing.*) The vessel in which the wort and hops are boiled.

Bri'ar-tooth. Properly BRIER-TOOTH (which see).

Brick. A molded and burned block of tempered clay. The word is also applied to the block in its previous conditions, as a molded plastic mass, and as a *dried* block in which the water, hygrometrically combined with the clay, is driven off. When this condition is accepted as a finality, the block so dried is an adobe. The *burning* of the previously *dried* brick drives off the chemically combined water, and forever changes the character of the mass. An adobe may become re-saturated with water, and resume its plasticity; a brick may become rotten and disintegrated, but not plastic.

Travelers on the Euphrates give extraordinary accounts of the mounds of bricks at Birs Nimrod, the supposed site of Babylon, and the remains of other cities of the stoneless plains of the Euphrates and Tigris. The men on the plains of Shinar who said, "Go to, let us make brick, and burn them thoroughly" (Gen. xi. 3; 2247 B. C.), and who laid them up with slime (bitumen), made a very thorough job of it, if the true site has been found. Rawlinson, Layard, Mignan, Rennel, and many others, have found at various places sun-dried and kiln-burned brick of large size and in incalculable quantity. The buried palace of Nebuchadnezzar has for a long series of years, indeed, provided bricks for all the buildings in the neighborhood; there is scarcely a house

Fig. 895.



Babylonish Brick.

in Hillah which is not almost entirely built with them.

"It was the custom of Nebuchadnezzar to have his name stamped on every brick that was used during his reign in erecting his colossal palaces. Those palaces fell to ruins, but from the ruins the ancient materials were carried away for building new cities; and in examining the bricks in the walls of the modern city of Baghdad, on the borders of the Tigris, Sir Henry Rawlinson discovered on each the clear traces of that royal signature." — MÜLLER, "Science of Language." See also "Researches of Della Valli," 1616; and Rich, 1815.

These bricks are red or pale yellow, and are sometimes disposed in mosaic. Their sizes vary 12 × 12 × 3 inches to 19½ inches square and 3½ thick. Some are rounded at the corners for quoins or special work. The bricks are almost universally stamped out of a mold, and impressed with cuneiform inscriptions in a sunken rectangular panel.

The inscription on the brick (Fig. 895) is, —

"Nebuchadnezzar
the King of Babylon,
founder of Beth-Digla, or Saggalu,
and of Beth-Tzida,
son of Nepolalazar."

From their peculiar form, the pressed cakes of tea which form so important a part of the Turcoman and Calmuck *cuisine* are known as *brick tea*.

Herodotus (450 B. C.), who had heard of this species of food, supposed it to be a kind of fruit, dried and pressed. He says: "The juice which runs off is black and thick, and is called by the natives [Scythians] *aschy*. They lap this up with their tongues, and also mix it with milk for a drink; while they make the lees, which are solid, into cakes, and eat them instead of meat." — HERODOTUS, IV. 23.

Their descendants do the same to this day.

The bricks of Thothmes III. are impressed with his cartouche. The Roman brickmakers had their special marks. The Twenty-second Legion has been traced through Germany by the bricks which bear its name. Roman bricks are found at Caer-leon, in England, inscribed LEG. II. AUG. Bricks at York, England, attest the presence there of the Sixth and and Ninth Legions.

Of the Egyptian bricks, the following proportions are given by Wilkinson: —

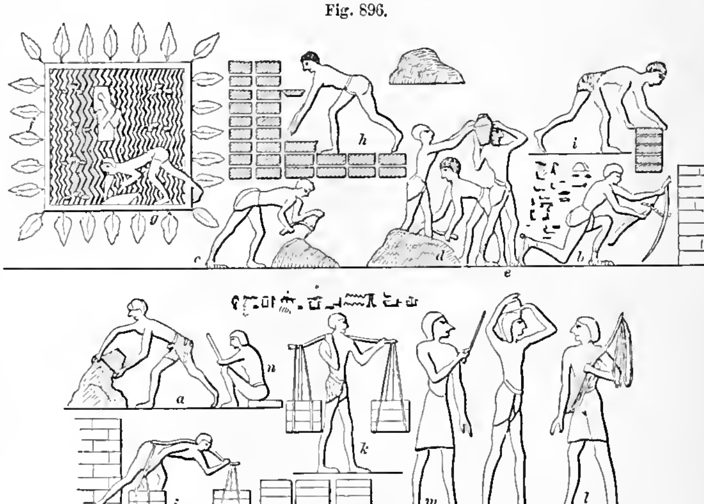
	A brick of Thothmes III.	One of Amounopt III. (in British Museum).	One from the Pyramid of Howara.
Length	12 in.	11.3 in.	17 in.
Width	9	5.8	8.8
Thickness	$6\frac{3}{8}$	3.9	3.8
Weight	$37\frac{10}{16}$ lbs.	13 lbs.	$48\frac{6}{16}$ lbs.

Enameled bricks, brightly colored, are abundant in the mound of the Mujellibeh, in Mesopotamia. The principal colors are a brilliant blue, red, a deep yellow, white, and black.

The bricks in the Pyramids of Dashour are adobe, 16 inches long, 8 wide, and 4½ thick; some made with straw and some without.

The mud of the Nile is the only material in Egypt for brickmaking, and the modern process is the same as the ancient, as may be seen by the drawings

Fig. 896.



Ancient Egyptian Brickmakers (Thebes).

on the tombs. The annexed cut is from a painting on a tomb in Thebes.

Some of the men (*a b c d*) are represented digging and mixing clay and mud; others are carrying clay (*e*), and dipping water from the river (*g*), and carrying it in jars; while others are molding bricks (*h i*), and laying them out on the ground to dry. *j k* are carrying bricks; *l* returning with his yoke empty;

m n are taskmasters. The modern plan is the same; a bed is made into which mud and water are thrown, together with large quantities of cut straw. This is tramped into a mortar, taken out in lumps, and shaped in molds, or by the hands. It is sun-dried, not burned. The bricks of Egypt, ancient and modern, are adobes.

The business of brick-making is believed to have been a royal monopoly in Egypt, and Wilkinson states that more bricks are found in Egypt with the stamp of Thothmes III. than of any other monarch. He is believed to be the prince who reigned at the time of the Exodus of the Hebrews.

A pyramid of brick was erected by Asychis, who, according to Herodotus, preceded the king who was dispossessed by Sabaco the Ethiopian, and who was restored and eventually succeeded by Sethos, a contemporary of Sennacherib and Tirhakah, about 700 B. C. Four pyramids of this material, according to Wilkinson, still remain in Lower Egypt, independent of several smaller ones at Thebes. Two are close to Memphis and the modern town of Dashoor; the others stand at the entrance to the Fyoom. They are built of adobes, and their chambers have arched brick ceilings; but the arch was long previously used in Thebes, and was invented and used in Upper Egypt many centuries before Asychis.

No trace of a burned brick has been found of the ancient age represented by the tumuli-builders of North America.

Strabo speaks of bricks made of an earth at Pitane, in the Troad, so light that they swam in water. Poseidonius speaks of bricks made in Spain "of an argillaceous earth wherewith silver vessels are cleansed [rottenstone], and so light as to float in water."

The Roman bricks, in the time of Pliny, were of three sizes, the largest a foot and a half in length by a foot in breadth, and called the Lydian. The names of the others were derived from their being respectively four and five palms in length. He cites the great use of them by the Greeks, and declares them unfit for use in Roman dwellings, where no party walls were allowed to exceed a foot and a half in thickness, and that thickness, he declares, "would not support more than a single story." The buildings in Rome were limited by Augustus to a hight of seventy feet. If Pliny could see some of our modern walls of six-story hight, he would tremble for the occupants. The inference is that wood was the principal material for building in Rome, and this view is confirmed by the extent and destructiveness of their fires. He farther cites that the walls of Babylon were of brick cemented with bitumen, and that the latter was imported from thence into Rome as a medicinal agent, and a material for varnishing heads of nails and various other articles of iron.

The Romans used large, thin bricks or wall-tiles as a bond in their rubble constructions, and such continued to be used in England until regular masonry was introduced shortly before the Norman Conquest, 1066. After the great fire of London, 1666, brick was substituted for wood in the erection of buildings in London.

The ancient nations excelled in the quality of their bricks, which was probably owing to the abundance of labor, good sunshine, and patience. The thorough working and tempering of the clay, to develop its plastic quality, followed by good drying, lengthened seasoning, and careful burning, will account for the quality. In China, the potters work up the clay provided by their fathers, and lay up a store to ripen for their children. Brickmaking in Greece was placed under legal supervisors.

The walls of the city of Athens, we learn from Pliny, were made of brick on the side towards Mt. Hymettus. Many of their other public buildings were of brick, as were also those of the Romans. An attempted enumeration would become tedious. The palaces of Crœsus, king of Lydia (548 B. C.), of Mansolus, of Halicarnassus (352 B. C.), the Bath of Titus (A. D. 70), the Pillar of Trajan (A. D. 98), and the Bath of Caracalla (A. D. 212), were of brick. The latter yet bears witness to the quality.

Among many of the Asiatic nations the bricks are of excellent quality. Those of China are faced with porcelain, and in Nepaul they are ornamented by the encaustic process and in relief.

The conquerors of Peru found the art of brickmaking in a flourishing condition in the Empire of the Incas, and both there and among the more northerly countries of Yucatan and Mexico, we learn from the Spaniards, and from Humboldt, and also from our own historians and travelers, Prescott, Stephens, and Squier, that the architectural remains of former races are still extant in brick as well as in porphyry and granite.

Bricks were made in England by the Romans A. D. 44. Made under the direction of Alfred the Great, A. D. 886. The manufacture flourished remarkably under Henry VIII. and Elizabeth. The size was regulated by Charles I., 1625.

The operations of brickmaking may be said to consist in —

Preparing the brick-earth.	Drying.
Tempering.	Burning.
Molding.	

The qualities of bricks may be thus enumerated: —

Soundness; that is, freedom from cracks and flaws.

Hardness; to enable them to withstand pressure and strain.

Regularity of shape and size; to enable them to occupy their proper place in the course.

Infusibility; in those intended for furnace-work.

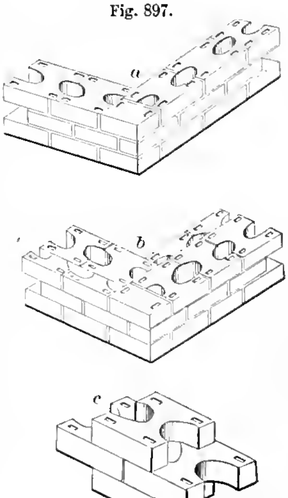
Fire-bricks are made from a compound of silica and alumina, and the clay owes its refractory quality to the absence of lime, magnesia, potash, and metallic oxides, which act as fluxes.

Hollow bricks are made for purposes of warming, ventilating, and removing moisture from the wall. In some cases the hollows form flues, or shafts for ventilation, or discharge of dust from the upper stories. In other cases the hollows have no mechanical function other than to form air-chambers for warmth, as it is well known that an imprisoned body of air is a very poor conductor of heat. Prince Albert's tenements at Knightsbridge were built of hollow bricks, and were held to be a success in this respect.

a (Fig. 897) represents a 9-inch wall finished with a common brick at the angle.

b shows a 14-inch wall, a half-ventilating brick being used alternately in the courses.

Fig. 897.

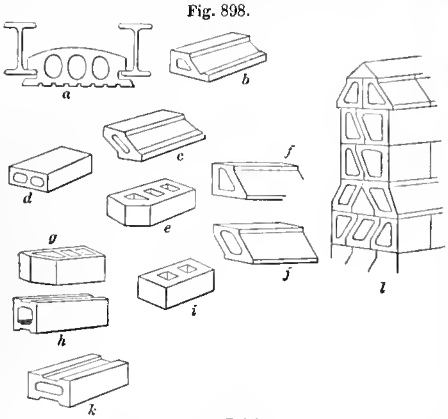


Ventilating Bricks.

c shows the relation to each other of the ventilating spaces, so as to make the openings continuous.

Hollow bricks were used by the Romans in large vaultings, and are said to be common in Tunis, Africa. They are made by machines similar to the tile-machines or by hand. They are made of various shapes, to suit ordinary wall-work, angles, reveals, jambs, chimneys, floors, arches, copings, etc.

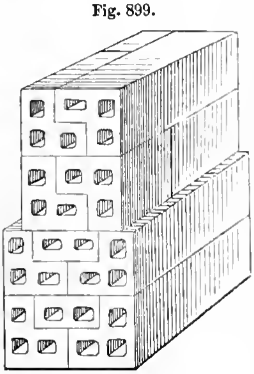
Fig. 898.



Hollow Bricks.

a is a hollow brick for ceilings, having lips which rest on the lower flanges of the girders. The bricks indicated by letters *b* to *k* are of various forms, and their uses are indicated by the section of parapet wall shown at *l* and by Fig. 899. They are external and internal, quoin, jamb, and splay bricks.

Fig. 899.



Hollow Bricks.

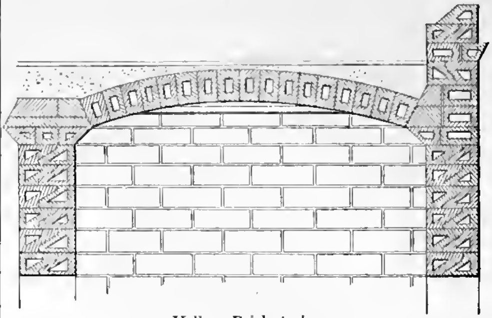
Fig. 899 is a section illustrative of the construction adopted in Prince Albert's model houses. The span of the arches is increased over the living-rooms to 10 feet 4 inches with a proportionate addition to their rise. The external springers are of cast-iron, connected by wrought-iron tie-rods.

It is stated that there is an advantage of 29 per cent in favor of the hollow bricks over the ordinary bricks, in addition to a considerable diminution in the cost of carriage or transport, and 25 per cent on the mortar and the labor.

Bricks are glazed or rendered waterproof by a composition which gives them a vitreous surface. This is performed by treating the surface with a flux which melts the silex of the brick, or it may be applied to the surface in solution, the liquid being afterwards expelled by heat. Resinous compounds have also been used to render the surface non-absorbent. They have also been treated with soluble silicate of soda, which has been decomposed, leaving the insoluble silex in the pores of the brick. Pigments added to the glazing compounds give an ornamental appearance. See BRICK-MACHINE.

Varieties of bricks are known by names indicative of material, quality, shape, and purpose.

Fig. 900.



Hollow-Brick Arch.

Air-brick is a grating the size of a brick, let into a wall to allow the passage of air.

Arch-brick usually means the hard-burned, partially vitrified brick from the arches of the brick-clamp in which the fire is made and maintained.

A brick made voussoir-shaped is known as a *compass*-brick.

A *capping*-brick is one for the upper course of a wall.

Clinker; a brick from an arch of the clamp, so named from the sharp glassy sound when struck.

A *compass*-brick ; one voussoir-shaped for arches.

A *coping* brick ; one for a coping course on a wall.

Feather-edged brick, of prismatic form, for arches, vaults, niches, etc.

Fire-brick made of intractable material, so as to resist fusion in furnaces and kilns.

Hollow-brick, with openings for ventilation.

Stocks; a name given locally to peculiar varieties, as gray-stocks, red-stocks, etc.

Pecking, place, sandal, samel brick, are local terms applied to imperfectly burned or refuse brick.

Bricks vitrified by excessive heat are termed *burr-brick*.

The specific gravity (average) is 1.841 ; the weight of a cubic foot, 115 pounds, which absorbs $\frac{1}{15}$ of its weight of water ; the cohesive force of a square inch is 275 pounds (Tredgold) ; it is crushed by a force of 562 pounds on a square inch (Rennie).

Weight of a cubic foot of newly built brick-work is 117 pounds ; the weight of a rod of new brick-work is 16 tons.

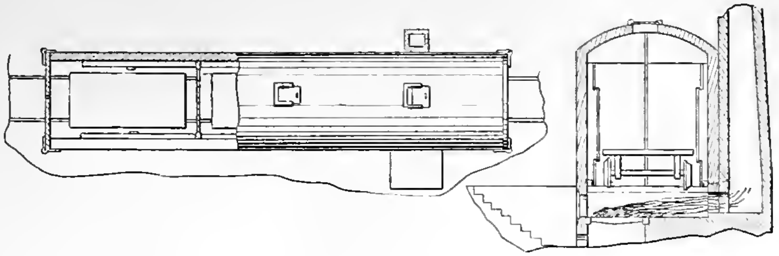
Brick-axe. (*Bricklaying.*) An axe with two ends, which are presented like chisels. It is used in chopping off the soffits of bricks to the saw-kerfs, which have been previously made in the brick to the required depth, in order to prevent the brick from *spalling*.

It is used generally in dressing bricks to a shape for arches, niches, domes, etc.

Brick-clamp. A stack of bricks in order for burning.

Bricks are burned in clamps and kilns. The former is commonly adopted in the neighborhood of London, where the *breeze* is mixed with the clay and forms the fuel by which the brick is burned. A clamp is also the name given to a pile of bricks which are built into the proper form for firing. Many variations in the modes of building clamps will be found in different places, but one successful method may be described in general terms as consisting of a number of walls or "necks," 3 bricks thick, about 60 bricks long, and 24 to 30 bricks wide, in an inclined position on each side of an upright or double battering-wall in the center of the clamp, the up-

Fig. 901.



Brick-Drying House.

right being of the same hight as the necks, but diminishing from 6 bricks thick at bottom to 3 bricks thick at top. The sides and top of the clamp are cased with burned brick, and are sometimes daubed with clay. "Live" holes or flues are made throughout the length of the clamp for the reception of the kindling when the bricks are burned with layers of breeze. In cases where they are burned by regular firing, the bricks are so clamped that openings are left for the fire in every direction. The outer layers are "close bolted," as it is called, which means that they are laid as close as possible; when they are stacked so as to allow intervals or spaces, they are said to be "scintled."

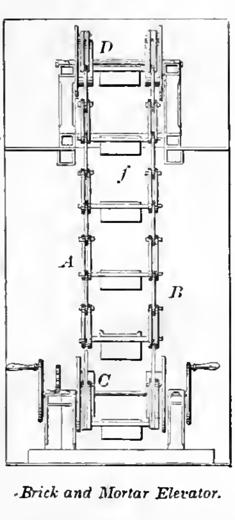
For details and particulars see "Dobson on Brickmaking."

Brick-dry′er. An oven in which green bricks are dried, so as to fit them for building up in clamps or kilns for burning.

A series of drying-chambers are separated from each other by iron folding-doors, through which chambers a railroad track is laid. Under one end of the structure is a furnace, and hot air, of increasing degrees of temperature, is introduced successively into the separate chambers.

Brick-el′e-va′tor. An apparatus for raising materials used in construction. In that shown, the endless chains *A B* are carried over wheels *C D* above and below, and the material is carried up on boxes supported by frames attached to the chains.

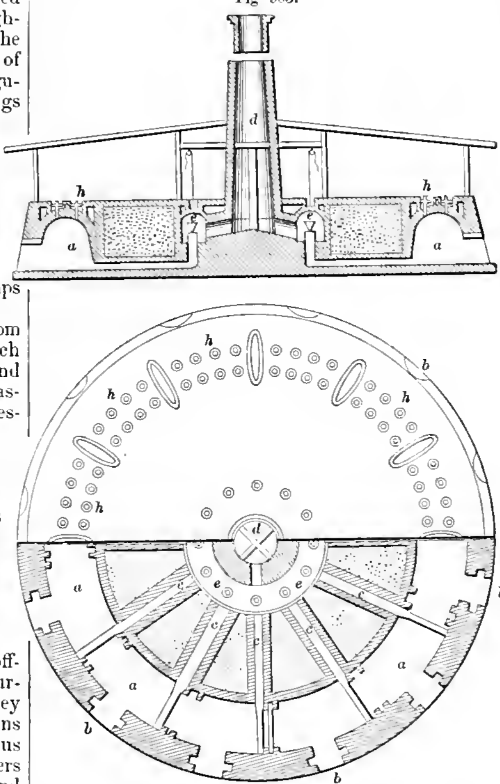
Fig. 902.



Brick and Mortar Elevator.

Brick-fur′nace. Hoffman's annular brick-furnace has a central chimney *d* and removable divisions for separating the annulus into different chambers *a a*. These are filled and emptied through doors *b*, and *c c* are valved passages leading to the drum *e* around the chimney *d*. *h h* are openings to introduce powdered coal into the chambers *a* on top of the bricks. The chambers *a a* being charged with brick, heat is applied to one chamber, and the volatile results are led through the next one, so as to heat and dry the bricks in the next in series. The bricks in chamber one being burned, the fire is applied to number two, and the heated air led therefrom through chamber three to the outlet *c* and chimney *d*. The air to feed the fire in chamber two is led through chamber one to cool the bricks.

Fig 903.



Brick-Furnace.

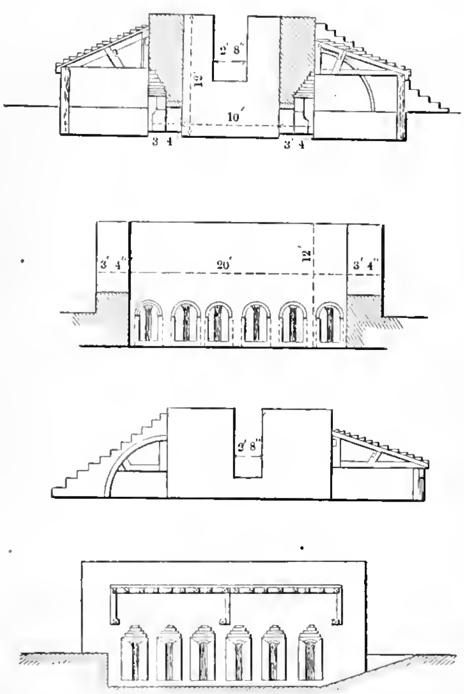
Brick′ing. The imitation of brick-work on a plastered or stuccoed surface.

Brick-kiln. A chamber in which green bricks are loosely stacked, with spaces between them for the passage of the heat, and in which they are burned by fires placed either in arched furnaces under the floor of the kiln, or in fire-holes placed in the side walls.

One form consists of four upright walls inclosing a rectangular chamber. The floor is sunk about four feet below the general surface of the ground, and is not paved. The doorways for setting and drawing the kiln are merely narrow openings at the side of the kiln raised a step above the ground, and about five feet from the floor. The fire-holes are arched openings oposite to each other on the sides of the kiln, lined with fire-bricks, which require to be renewed from time to time, generally every season. The width of these holes is reduced to the required space by temporary piers of brick-work, so as to leave narrow openings about eight inches wide and three feet high.

On each side of the kiln a pit is sunk to the level of the floor, and covered with a lean-to roof, which

Fig. 904.



Brick-Kiln.

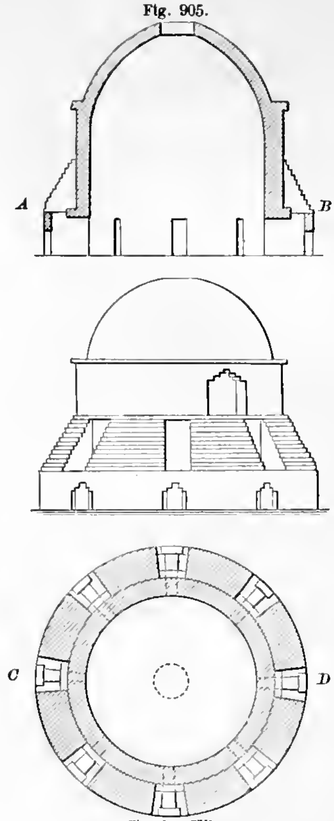
protects the fuel and the fireman from the weather, and prevents the wind from setting against the fires. The walls of the kilns are about three feet thick, and are built of old bricks, rubble-stone, and the refuse of the yard. No mortar is used, as the use of lime would destroy the brick-work, and the bricks are set in loam or fire-clay.

The views (Fig. 904) represent respectively, —
A section through the sides.
A section through the ends.
An end elevation.
A side elevation.

The circular kiln or cupola (Fig. 905) is domed over at the top, whence its name is derived. The fire-holes are merely openings left in the thickness of the wall, and are protected from the wind by a wall built round the kiln at a sufficient distance to allow the fireman room to attend the fires. These cupolas are employed in Staffordshire, England, and vicinity, and the heat attained in them is very great.

In the illustration the figures are respectively, —
A section on line *C D*.
An elevation.
A plan at top of fire-holes at level *A B*.

Fig. 905.

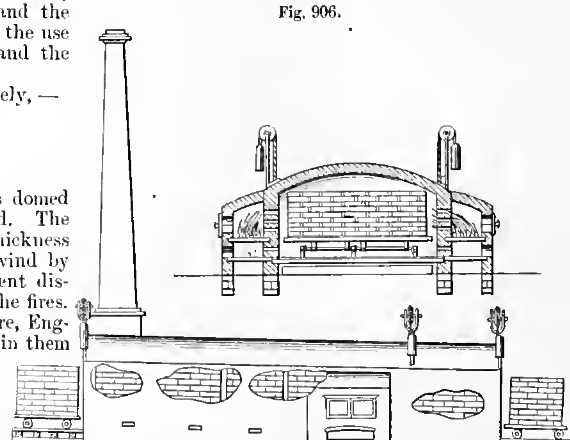


Circular Kiln.

Fig. 905 shows a progressive burning and cooling kiln, in which furnaces are arranged on each side of a chamber, in which latter are rails for carriages loaded with brick. Doors are provided at each end of the kiln, so that, when the brick on one carriage is burned, the doors are raised and a carriage of unburned brick is pushed against the others in the kiln, thus forcing out the carriage at the other end.

Air or steam have been introduced under pressure

Fig. 906.

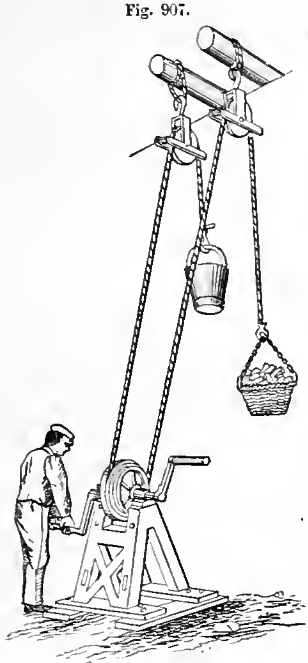


Brick-Kiln.

into burning brick-kilns for the purpose of distributing the heat from the hotter portions to parts where the heat is lesser. Other devices are for drawing air through a sectional kiln when the baking is completed, in order that a part of the accumulated heat may be employed in other sections of the compound kiln.

Brick'lay-er's Ham'mer. (*Bricklaying.*) A tool having a hammer-head and a sharpened peen, forming an axe for dressing bricks to shape.

Fig. 907.



Bricklayer's Hoist.

Brick'lay-er's Hoist. A winch and tackle for lifting bricks and mortar in building.

Brick'lay-ing. The implements of the bricklayer are a *trowel,* for spreading mortar and breaking bricks when a piece smaller than a whole brick is required ; a *hammer,* for making openings in the brick-work and for driving or dividing bricks, for which purposes one end is formed like a common hammer, and the other is broad and flattened, somewhat after the manner of an axe ; the *plumb-rule,* made generally of wood, having a longitudinal opening down its middle and a plummet suspended from its upper end, for carrying walls up perpendicularly ; the *level,* consisting of a long horizontal arm, having a perpendicular branch carrying a vertical arm from which a plummet is suspended ; a large *square,* for laying out the sides of a building at right angles ; a *rod,* usually five or ten feet long, for measuring lengths ; *compasses,* for traversing arches and vaults ; a *line* and *line-pins,* for keeping the courses straight and level as the work progresses ; and a *hod,* for carrying bricks and mortar to the workman.

Bricks are laid in courses so as to break joints, and their arrangement with regard to each other constitutes what is called the *bond.* There are two kinds of bond made use of in England and America, — *English* or *old English,* and *Flemish,* — the former, however, being much more commonly employed than the latter. See BOND.

See MASON'S and BRICKLAYER'S TOOLS, etc.

Brick-ma-chine'. Bricks have been made by machinery for many years. Some of the early United States patents, of which the record was unfortunately burned in 1836, are dated 1792, 1793, 1800, 1802, 1806, 1807, and a tolerably constant stream has followed them. About 122 patents were granted in the United States previous to June, 1836, for brick and tile machines, and more than 500 patents have since that time been granted for brick-machines. The number is rapidly increasing. In England, probably over half that number are on record for making brick.

It will be impossible in the space which can be devoted to that subject to do more than present a few examples of the different forms which have been brought forward. This will show the direction of invention in this line, and will suggest to the reader the various modes of forming a rectangular block of plastic clay. These are the terms of the problem. As usual, where important interests are at stake, the resolution has called a diversity of machines into existence.

Brick-machines are of several classes.

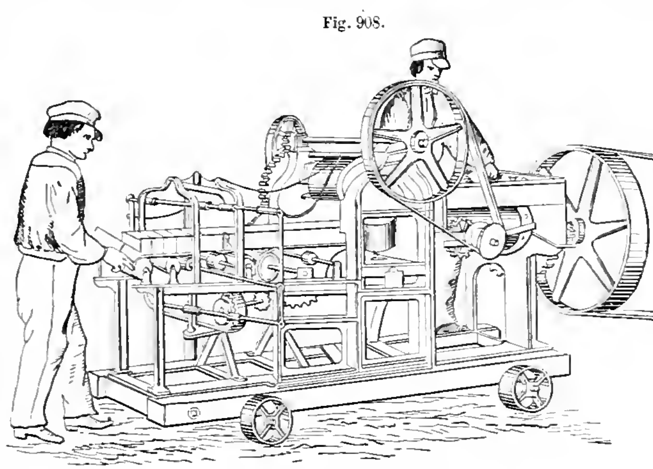
Class 1. Those in which a slab of clay exudes from the pug-mill, and is cut up into lengths which form bricks. The cutter is a wire or knife, and either travels with the slab while cutting, or moves in an oblique path, so as to make a square transverse cut across the moving slab.

CHAMBERLAIN's English machine is in principle as follows : —

The clay is fed into a pug-mill placed horizontally, which works and mixes it, and then forces it through a mouth-piece or die of about 65 square inches, or about half an inch deeper and half an inch longer than is required for the brick, of a form similar to a brick on edge, but with corners well rounded off, each corner forming a quarter of a 3-inch circle ; for clay will pass smoothly through an aperture thus formed, but not past a sharp angle. After the clay has escaped from the mill, it is seized by four rollers covered with a porous fabric (moleskin), driven at a like surface-speed from connection with the pug-mill.

These rollers are two horizontal and two vertical ones, having a space of 45 inches between them. They take this larger stream of rough clay, and press or roll it into a squared block of the exact size and shape of a brick edgeways, with sharp edges, — for the clay has no friction, — being drawn through by

Fig. 908.



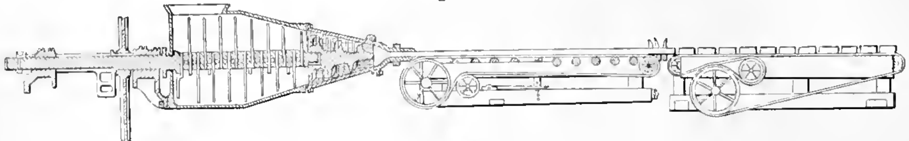
Chamberlain's Brick-Machine.

the rollers, instead of forcing itself through, and is delivered in one unbroken stream. The rollers in this machine perform the functions of the die in one class of machinery, and of the mold in the other. They are, in fact, a die with rotating surfaces. By hanging a series of mandrels or cores between these rollers, or by merely changing the mouth-piece, hollow and perforated bricks may be made without any alteration in the machinery. The slab is cut up into bricks by transversely-moving knives or wires.

In the brick-machine Fig. 909 the tempering-chamber, impelling-screw, and forming-die are in the same horizontal line, and of a conical shape, the forming-die being at the apex; the clay is received at the hopper on the cylindrical portion, worked by the beaters, and delivered to the screw which works at the end of the same shaft, and with a gradually increasing depth of thread terminates before it reaches the die, so as to make the clay leave in a solid mass; the walls of the screw-chamber are roughened to prevent the revolution of the clay.

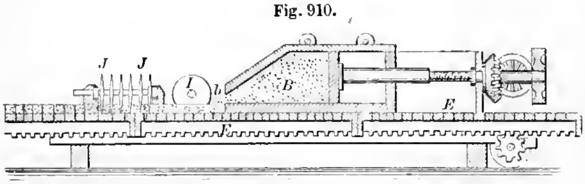
The clay is delivered upon an endless apron, by which it is carried to a knife working by attachment to a fly-wheel, which, being controlled by the same power, makes its cuts at regular distances in the traversing mass of clay; the latter is supported at the point of impact of the knife by a movable frame underneath, which moves with the knife, and the brick as it is cut off rests upon another apron, which, traversing faster than the former, soon makes an interval between the bricks.

Fig. 909.



Brick-Machine.

Fig. 910.



Brick-Machine.

In Fig. 910 the clay is forced from the reservoir *B* by the piston, which is driven by a screw and bevel-gearing. It issues through a throat or die, whose opening admits a wide slab of clay *b*, to be subsequently cut up by two series of knives, which divide it longitudinally and transversely. *I* is one of the knives, of which there are several on the same shaft; they are distant apart the length of a brick, and divide the slab into ribbons longitudinally. *J J* are a series of knives which are placed on a mandrel whose bearings are in a carriage, and the latter moves in ways across the path of the slab of clay and cuts the ribbons into bricks, the knives *J* being distant apart the width of a brick. The bed is made in sections *E E*, which are passed in succession through the machine by means of the racks and pinion.

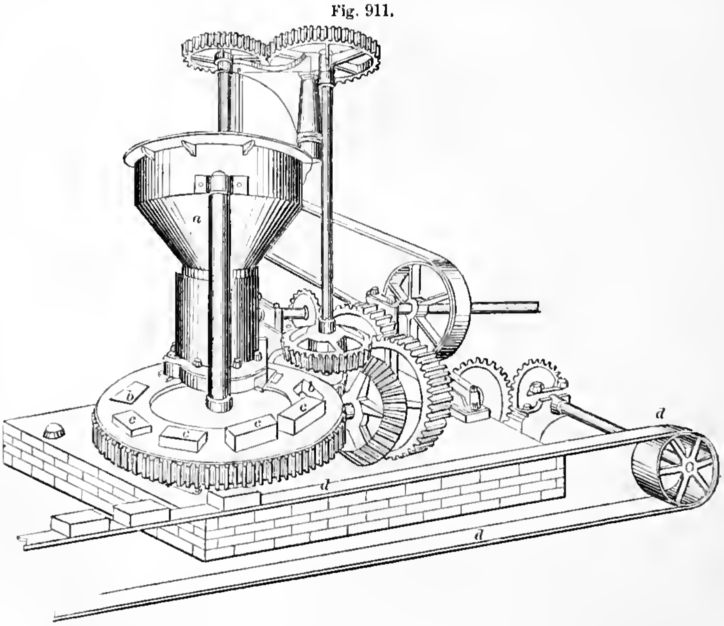
Class II. Those in which the clay passes from the pug-mill into molds, in which it is pressed, and from which the molded brick is discharged.

This class has six varieties: —

Var. 1: Those in which the molds are on the upper surface of a mold-wheel revolving in a horizontal plane, the molds being brought successively below the pug-mill, by which they are charged. The pressing and discharging devices vary in different machines.

Fig. 911 shows an English machine of this variety. It consists of a vertical pug-mill *a*, into the upper part of which the clay is fed. In this part of the apparatus the clay is tempered and mixed, and is thence forcibly pressed into the molds *b*, which are arranged in a circular revolving table. As this table revolves,

Fig. 911.



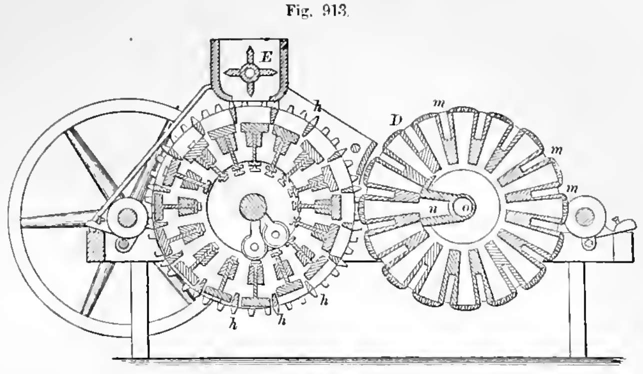
English Brick-Machine (from Ure).

the pistons of the molds ascend an inclined plane, and gradually lift the bricks *c* out of the molds *b*, whence they are taken from the machine by a boy and placed on an endless band *d*, which carries the bricks direct to the hacker.

The speed of the several parts of the machine is so arranged that the operations of pugging, molding, and delivering proceed simultaneously in due order, the whole being driven by a steam-engine of about 6-horse power, which, at the ordinary rate of working, will make 12,000 bricks per day, or, with 8-horse power, from 15,000 to 18,000.

Fig. 912 is an American form of brick-machine, of the same class and variety as the last.

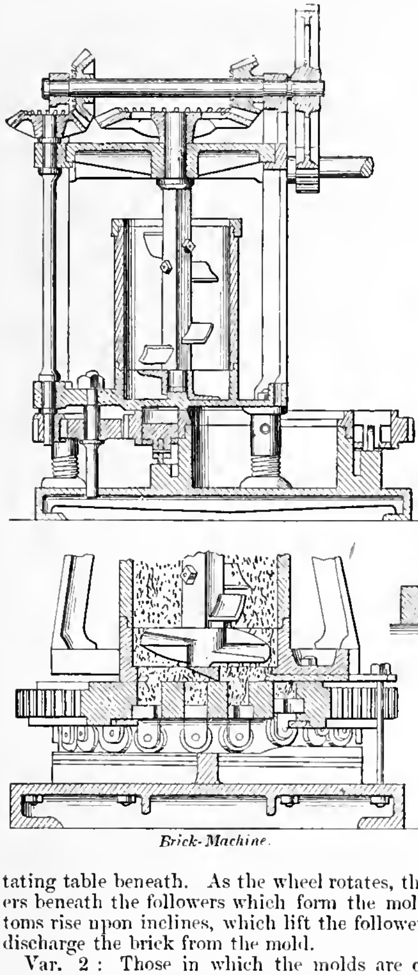
Fig. 913.



Brick-Machine.

The pug-mill shaft has a series of oblique arms, and at the foot has a pressing spiral which forces the tempered clay into the molds of the horizontally ro-

Fig. 912.



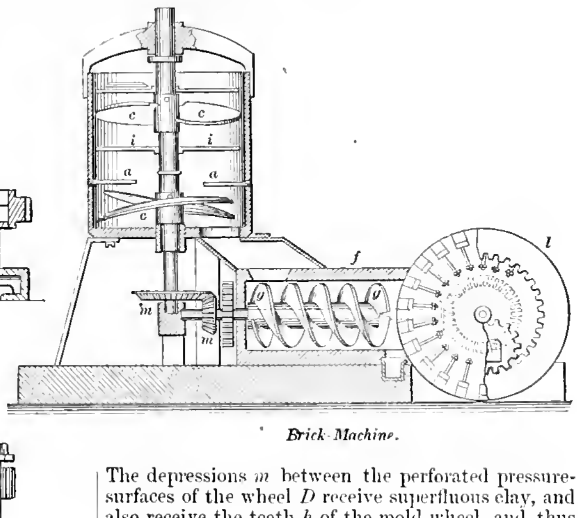
Brick-Machine.

tating table beneath. As the wheel rotates, the rollers beneath the followers which form the mold-bottoms rise upon inclines, which lift the followers and discharge the brick from the mold.

Var. 2 : Those in which the molds are on the periphery of a wheel, and receive their charge from a pug-mill or hopper above. The clay in the mold is pressed by the application of exterior or interior force, or both, and the molded bricks are discharged by piston-followers ; in most cases operated by cams or toggles.

In the example (Fig. 913) the pulverized clay passes from the hopper *E* into the molds in the periphery of the wheel below. The clay is pressed in the molds by the perforated pressing surfaces of the opposite wheel *D*. As each of these pressing surfaces comes in contact with the clay, it is also brought in contact with the trunk *n* and pipe *o*, which lead to an air-pump. The air is thus exhausted from the clay while the latter is under pressure.

Fig. 914.

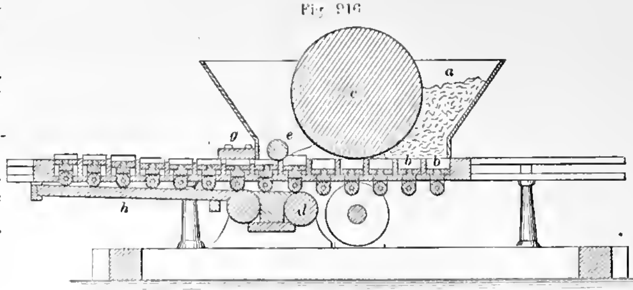


Brick-Machine.

The depressions *m* between the perforated pressure-surfaces of the wheel *D* receive superfluous clay, and also receive the teeth *h* of the mold-wheel, and thus insure the accurate meeting of the molds and pressers.

The machine (Fig. 914) has an upright hollow cylinder, through which passes a vertical shaft. To this shaft there are secured spiral flanges *c* and knives *i*, the latter being attached to the shaft horizontally in pairs. To the inner side of the cylinder there are secured horizontal knives *a*, having a radial position. Below the upright cylinder is a box *f*, in which is placed a horizontal screw *g*, which conveys the clay to the molds, the shaft of the said screw being connected to the vertical shaft by bevel-gears *m*. In the rear end of the box which contains the screw is mounted a wheel *l*, having its periphery perforated with rectangular openings which form the brick-molds, each mold being provided with a piston or plunger. In the lower part of the box, and just in the rear of the wheel, is fitted transversely a box which serves as a scraper to take the superfluous clay from the periphery of the wheel, and to smooth and compact the clay at the surfaces of the molds. As the latter come to their lowest position, the followers are moved and eject the bricks.

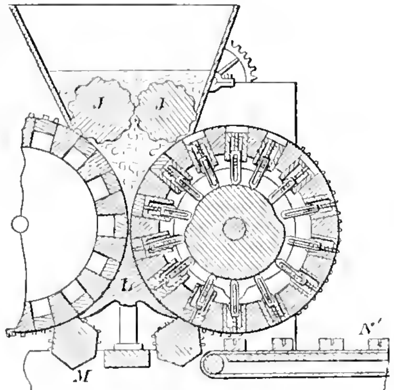
Fig. 916



Endless Succession Brick-Machine.

Var. 3: Those in which two wheels are provided with peripheral molds which are charged with clay from a hopper above, and in which the pressure is derived in whole or in part from the contact of the peripheries of the wheels with each other. Of this variety and class is Fig. 915. The corrugated feed-rollers *J J'* in the hopper drive down the clay, which enters the molds in the peripheries of the contacting cylinders. On the faces of the said cylinders are alternate molds and spaces, the latter forming pressure-surfaces for the clay in the molds of the opposite cylinder. The cylinders are counterparts of each other and are coöperative, being geared together so as to run in exact correspondence. Each mold has its piston or follower, which is moved radially by contact with a cam on the main-shaft of its cylinder. As soon as the mold passes the edge of the dividing block, the cam commences to thrust out the follower and reduce the brick to a smaller compass, pressing it against the face of a roller. This gives the outer face of the brick a concave form, but it is presently brought against one of the facets of the hexagonal roller *M*, which is so geared as to present its surface to the openings of the mold in a given cylinder in succession. When the mold reaches the lowest position in its revolution, the follower is farther advanced and discharges the molded brick on to the off-bearing apron *N'*. This description of the action in one mold is true of each mold in each of the cylinders. By way of giving farther compression, spring-plungers are advanced, after passing the divider *L*, and make a perforation in the brick which is retained, as the plunger is not retracted until after the brick has passed the last point of pressure.

Fig 915.



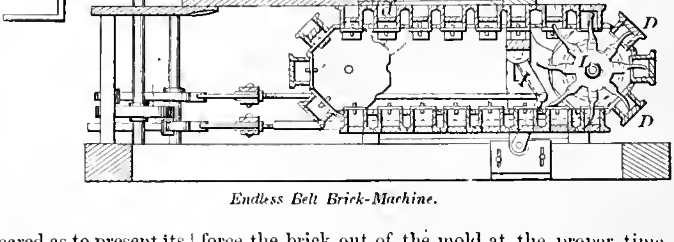
Double-Cylinder Brick-Machine.

Var. 4: Machines in which a series of molds are linked together to form an endless series, or are placed on an endless belt or track, and are passed beneath the charger, from whence they pass to the presser.

Fig. 916 is an illustration of this variety. The clay passes from the hopper *a* into the molds *b b*, and is pressed thereinto as they run beneath the pressure-roller *c*. The follower at the bottom of each mold is raised by the contact of its carriage with the roller *d* beneath the track. The effect is to partially remove the brick from its mold and expose it to the pressure of a second roller *e*. It then passes under a smoothing-block *g*, after which the follower-carriage climbs an inclined plane *h*, which elevates the brick from the mold. The molds are contained in a sliding frame which runs beneath the pug-mill, and, after discharging the bricks, returns empty to commence a new stroke.

In Fig. 917 the molds, in an endless chain, hinged together and running over two sprocket-wheels, are provided with movable bottoms, which are acted upon to press the contents of the mold, and also to force the brick out of the mold at the proper time. *a* is the pug-mill, and *b* the chamber from which the clay is ejected by the oblique arms *c*, being received

Fig. 917



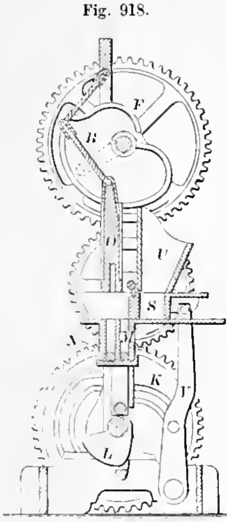
Endless Belt Brick-Machine.

into molds in the boxes *D* as they pass in turn beneath the throat in the bottom of chamber *b*. As the mold passes this point, it receives pressure from the intermittingly operating plunger attached to the toggle *I*, and shortly after the mold-bottom *d* is lifted by a spoke of the discharging-wheel *L*, which ejects the brick.

Var. 5: Machines in which the clay is molded by the force of a reciprocating piston or pistons.

The operation of the machine (Fig. 918) is as follows: The clay passes from the hopper *U* into box

Fig. 918.



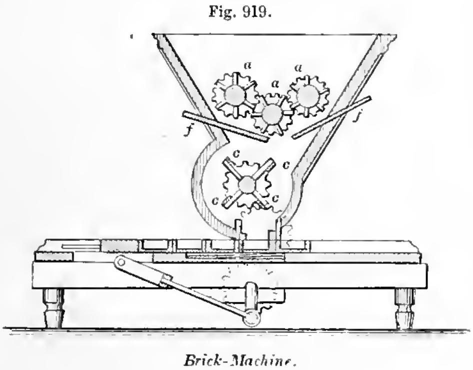
Piston Brick-Press.

S; the latter is then moved by the cam *K* and the intermediate arm *V*, shifting the charge of clay over the mold *M*, into which it drops. The box *S* then retires, and the plunger *O* descends, being driven by toggle *B*, and compresses the clay in mold *M*. The cam *F*, which regulates the motion of the said plunger, then causes the plunger *O* to rise, and cam *L* raises the plunger *N*, which removes the brick from the mold, to be swept from the table by the next forward movement of the box *S*.

Var. 6: Machines in which the molds are reciprocated beneath the pug-mill.

In Fig. 919 the clay is mixed and forced out of the hopper by the revolving spiked wheels *a*, and passes between the plates *f f*, whose distance regulates the rate of passage of the clay. The beaters *c c* drive the clay into the molds beneath, which are intermittingly advanced by a sliding-block, which is reciprocated by a pitman and crank deriving their motion from the shaft below.

Fig. 919.

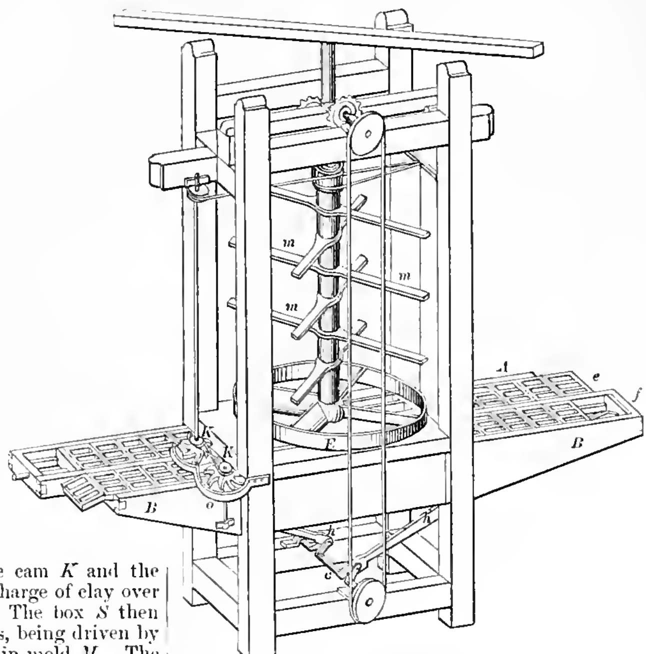


Brick-Machine.

In Fig. 920 the casing-cylinder of the pug-mill is removed, to expose the blades *m m* to view.

Motion being given to the shaft *c*, the cranks and pitmans *h* and *h'* operate the shoving-boards *e* and *f*, on which the molds are placed; the molds are thus moved on the two tables *A* and *B* in an opposite di-

Fig 920.



Brick-Machine.

rection, and at each revolution of the shaft *c* one row of molds on one table is filled with clay from the hopper, while on the other table an empty mold can be replaced behind the shoving-boards *e* and *f*: thus an operator, standing at the end of the tables *A* and *B*, can replace the empty molds on one table and withdraw the filled molds from the other table at the same time.

The blades on the shaft in the pug-mill mix and depress the clay, which passes through holes in the floor corresponding to the position of the molds, which are passed below by the intermittent motion described. The wheel *E* has blades which scrape the clay from the pug-mill floor. The supplementary scrapers *K K*, and curved guard *o*, remove the superfluous clay from the molds. The latter are removed by the off-bearers, and the contents dumped upon the floor of the drying-ground.

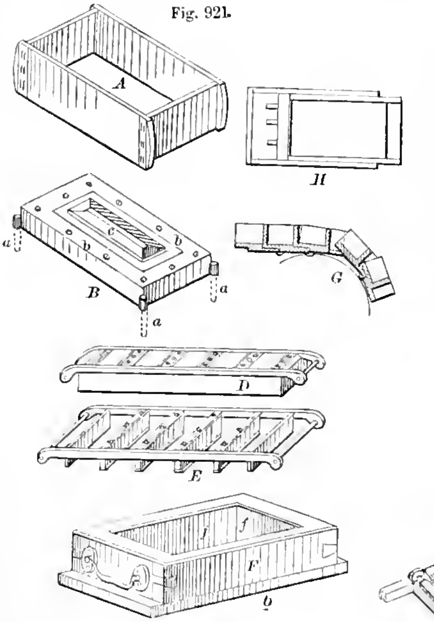
Class III. Those in which clay in a nearly dry state is compressed by a plunger into a mold, from which it is discharged after receiving a pressure, which causes the remaining moisture to form a bond of cohesion between the particles.

The functions of these machines refer to means for extreme pressure and the extraction of the air which accompanies the crumbly material into the mold. In other respects the machines of this class are somewhat like the piston-machines of Class II., Var. 5. For this purpose an adaptation of the hydraulic press is especially applicable and is in use. Bricks are also made of dried and pulverized clay, mixed with a due proportion of sand and perhaps lime, and molded under hydraulic pressure.

Brick-mold. A box in which clay for bricks is molded into shape. The adobes of the Orient, ancient and modern, and of the Western plains, are made by filling with clay a four-sided box, pressing it down compactly, and cutting off the superfluous clay evenly with the edge of the box. The box is usually destitute of top and bottom, lies upon a board while being filled, and, when lifted, leaves the brick in position to dry.

Brick-molds may be lined with iron or brass from which the molded brick slips more readily than it does from wood. The sand in the clay wears away the surface very fast, especially when lined with brass. It is sometimes made of sheet-iron in four pieces, riveted together at the angles, and strengthened with wood at the sides only. The bottom of the mold is detached, and forms what is called the *stock-board b*. The latter is a piece of wood plated with

Fig. 921.



Brick-Molds.

iron round the outer edge, and made to fit the mold accurately but easily. At each corner an iron pin *a* is driven into the molding-table, and on these pins the bottom of the mold rests, the thickness of the brick being regulated by the distance to which the pins are driven below the top of the stock-board.

In England, the surface of the brick which is to form the *bed*, that is, the bottom, has a depression to hold a mass of mortar. To make this is the purpose of the piece *c*, which projects above the general surface of the stock-board *b*.

A B are the corresponding parts of an ordinary mold, the upper four-sided portion *A* resting upon the lower portion *B* while being filled. *E* is a frame containing a number of division boards intended to be slipped into box *D*, to mold five bricks at once. The frame and box, being lifted, leave the bricks upon the ground to dry. *F* is a mold of wood lined with glass *f*.

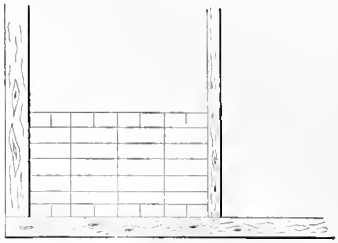
G represents part of a chain of molds as found in some kinds of brick-machines.

H is a mold which has an advancing piston with three punches designed to make openings into the brick for the more ready exit of the air. Used in *re-pressing* brick-machines, which gave a great pressure at a second operation, or act with a great pressure upon prepared clay, which is apparently dry.

Brick-nog′ging. (*Building.*) Called also *brick and stud* work.

A *brick-nogging* wall or partition is one in which

Fig. 922.



Brick-Nogging.

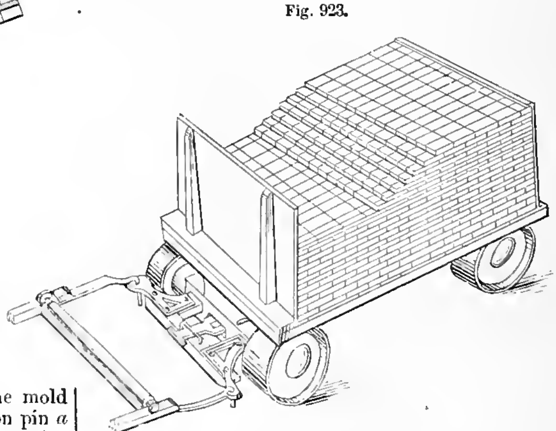
the spaces between the timbers or scantling are filled up with brick laid in mortar. In a brick-nogging partition the wooden portions are called *nogging-pieces.*

Brick′-press. See Brick-machine.

Brick-trim′mer. (*Building.*) A brick arch abutting upon the wooden trimmer under the slab of a fireplace, to guard against the communication of fire.

Brick-truck. One with wide tires to travel over

Fig. 923.



Brick-Truck.

the flat surface of the brick-yard in moving brick from the hack to the kiln.

Brick-work. (*Bricklaying.*) The English regulation brick is $8\frac{1}{2} \times 4 \times 2\frac{1}{2}$ inches. Of such, —

One foot of brick-work ($1\frac{1}{2}$ bricks thick) contains 17 bricks.

One foot superficial of Flemish bond requires 8 bricks.

One cubic foot comprises 125 bricks, or 95 pounds of sand, or 135 pounds of clay, or 126 pounds of common earth.

One great ton weight (2,240 pounds) comprises

330 bricks, or $23\frac{1}{2}$ cubic feet of sand, or $17\frac{1}{3}$ of clay, or 18 of earth.

One cubic foot of brick-work weighs 120 pounds; 1 rod of fresh brick-work ($11\frac{1}{4}$ cubic yards) weighs 35,840 pounds.

Bridge. 1. (*Engineering.*) A structure erected over a water-way, ravine, or road, for the transit of persons, animals, or vehicles. A *viaduct.*

The only reference to a bridge in the canonical Scriptures is an indirect one, in a name referring to the "bridge of the sons of Jacob." It is at a place northeast of the Sea of Galilee, and a bridge still exists at the place.

The bridge erected by Nitocris, across the Euphrates at Babylon, consisted of stone piers supporting a series of wooden platforms, which were capable of being withdrawn, to prevent passage at night between the portion of the city on the respective sides of the river. (HERODOTUS, I. 186.)

The "huge stones cramped together by iron bars and melted lead" were probably in the piers. We may surmise that the foundations of these were laid while the river was temporarily diverted, or made in an artificial channel to which the river was subsequently transferred. Either plan was possible in that country, and the former was tried, to the cost of the Babylonians, by Cyrus, many centuries after Nitocris.

Ancient bridges of great magnitude exist in China. This ingenious people constructed them of wood, stone, chains, and ropes, before history commenced to be written in Europe. The great wall of China (*Wan-li-chang*, the myriad-mile-wall) was finished about 220 B. C., and has many stone bridges over the various streams which it crosses in its course of 1,250 miles. It puts into the shade the British wall of Agricola, which united the Tyne and the Solway, 80 miles; and the other Roman wall which united the Forth and Clyde, 36 miles.

The Egyptians built no permanent bridges across the Nile, but were familiar with framing trestle-work, and with ponton and draw bridges; the latter are seen frequently in their paintings representing fortified towns, sieges, etc.

The Greeks had but small rivers, and had no stone bridges until after the Roman conquest.

We learn from the Greek historians that bridges were constructed by Cyrus (536 B. C.), Darius (490 B. C.), Xerxes (480 B. C.), and Pyrrhus (280 B. C.). Each of these was a military bridge for a special purpose, and had no permanent character. The bridge of Cyrus, over the Meander, was supported on boats, like those which crossed the Bosphorus and the Hellespont under the orders of his successors; Xenophon states that the bridge of Cyrus had seven boats.

The bridge of Xerxes was 500 paces in length. Ships were used as pontons; cords of flax and biblos united them; transverse beams were laid on the ropes; planks on the beams; soil on the planks; and the armies crossed thereon. Cords and posts at the sides afforded some degree of protection.

How many bridges were built by Pyrrhus in his expeditions, history does not inform us; but the bridges in his Italian campaigns, about 280 B. C., over the streams emptying into the Adriatic, are mentioned by the Greek historians.

The first bridge in Rome was built across the Tiber, 621 B. C., by Ancus Martius, uniting the Janiculum and Mons Aventinus, and was memorable for its defence by Horatius Cocles against Lars Porsenna the Etruscan, about 508 B. C.; also as the spot whence the body of Heliogabalus was cast into the Tiber, a stone about his neck, about A. D. 218. It was called the Pons Sublicius, from its having been built upon stakes, or piles. The original bridge was built about the time of Josiah, king of Judah, and a few years previous to Nebuchadnezzar.

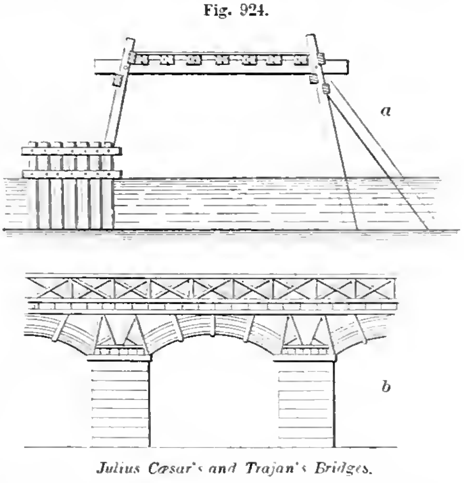
The Pontus Salarius was erected by Tarquinius Priscus, about 600 B. C. It spanned the Teverone, and is believed to have had three arches of stone. Doubts have been suggested as to the authenticity of this account; but it is not surprising when we consider the *Cloaca Maxima*, constructed in the same reign.

The Romans appear to have been the first to construct arched bridges; several of which still exist in Syria and Palestine, and are the oldest stone-arch bridges in existence, unless some of the Etruscan and Chinese bridges antedate them.

The Pons Senatorius was erected across the Tiber by Caius Flavius Scipio, 127 B. C.

A trestle-bridge on piles (*a*, Fig. 924) was built by Julius Cæsar across the Rhine about 55 B. C. He left an account of its construction, but the authorities construct it differently from the specification extant. It was founded upon piles driven into the bed of the river. The piles were united by

Fig. 924.



Julius Cæsar's and Trajan's Bridges.

a beam, on which were laid joists in the direction of the length of the bridge. Upon the joists were laid hurdles supporting the road-bed. An inclined fender protected the piers up stream, and each pier was stayed below by a cluster of piles. It was built in ten days.

A magnificent bridge with four stone arches was built by Augustus near Narni, on the road from Rome to Loretto. The arches were respectively 75, 135, 114, and 142 feet span. One arch remains.

The bridge of Trajan (*b*, Fig. 924), which crossed the Danube, was one of the greatest engineering works of antiquity. It was constructed of timber resting upon stone piers. Each span consisted of three rows of concentric arches, united by binding-pieces formed upon each division: these abutted upon timbers radiating with the curve, which were framed into heads and sills, again strengthened by braces and struts: the joists which carried the floor traversed the bridge, and rested upon strong plates laid upon the timber arches.

Apollodorus was the architect, A. D. 105. The bridge was 4,770 feet long. The foundation was made by sinking large barges filled with stones, lime, and sand, and filling in the interstices with bags of similar material. On these the piers were built. The bridge had 20 semicircular arches of 180 feet 5 inches span. Their springings were 46 feet above the general level of the river. The piers were 150 feet high above their foundations, 64 feet thick, 85 feet 3 inches wide. The bridge was 60 feet wide.

It was destroyed by Hadrian, the successor of Trajan, to prevent the incursions of the barbarians. Rome was then beginning to assume the defensive.

Among the other Roman bridges which yet remain, whole or in part, to testify to the skill of the engineers and extort our admiration, are those of Merida and Alcantara, in Spain. The former is over the Guadiana, 3,900 feet long, and has 64 arches. The latter is over the Tagus, 670 Spanish feet long, 6 arches; road-bed 205 feet above the river.

The bridges of London are celebrated in history, especially that portion of history in which we who speak English are most interested. A wooden bridge existed over the Thames in A. D. 978. One was built of wood in 1014; one by Peter of Colechurch, 1176–1200, with houses on each side connected by arches of timber which crossed the street. This was burned in July, 1212, and 3,000 persons perished. The buildings being on fire at the Surry end, a great crowd rushed to see the fire, and the wind blew the burning shingles to the north end, lighting the buildings at the Middlesex side of the river. Between fire and water the loss of life was dreadful. The bridge was restored in 1300; again partially burned in 1471, 1632, and 1725. The houses were pulled down in 1756. At what time stone arches were substituted for wooden spans does not appear. When the present London bridge was built in 1831, the elm piles of the old bridge were yet sound, after 600 years' use.

In the twelfth and thirteenth centuries A. D. a very useful society flourished in Europe, called the "Brothers of the Bridge." The building of bridges was at that time deemed an act of piety, and we must highly respect that devotion which, in the fear of God, finds its expression in deeds of exalted usefulness.

Benezet built a bridge at Avignon over the Rhone, which was finished in 1188. It had 18 stone arches, and was 3,000 feet long. The arch which supported the chapel dedicated to St. Nicholas, the patron of sailors and those whose business is upon the waters, remained long after the other arches had been swept away by the storms of centuries. Benezet's tomb was in the crypt.

About 1300, Issim, the Moorish king of Granada, erected a fine bridge at Cordova, across the Guadalquiver.

Perronet mentions a stone bridge of three arches, one of which had a span of 159 feet 9 inches, at Verona, erected in 1354. Also a bridge with a stone arch 183.8 feet span, 70.6 feet rise, erected 1454, at Vielle Bronde, over the Altier, by Grennier.

The Rialto, of Venice, was erected by Antonio del Ponte, 1588. It has a span of 98½ feet.

The art of bridge-building, which was understood by the Romans, fell into disuse when that political system became disintegrated. When the arts revived, the Italians took the lead.

Much has been done of late years, and the designs become more and more bold. London Bridge, Menai Tubular Bridge, the St. Lawrence Bridge at Montreal, the Cincinnati Bridge, Southwark Bridge, London, the Cabin John Creek Bridge, Maryland, and the Schuylkill Bridge at Philadelphia, are trophies of their kind. The suspension bridge across the East River, New York (see Frontispiece), is by far the boldest undertaking in the suspension line, nearly 600 feet greater than the now widest span, — the bridge at Cincinnati. The steel tubular-arch bridge at St. Louis is to cross the Mississippi in three spans, which have only one rival among arches, — a single-span bridge in Holland.

The highest bridge in the world is the Verrugas Viaduct on the Lima and Oroya Railroad, in the Andes of Peru. It crosses a mountain-torrent called the Agua de Verrugas, in a wild and picturesque locality 12,000 feet above the level of the sea. The structure consists of four deck-spans, or trusses, three of which are 110 feet long, and one, the central span, 125 feet long. The spans rest on piers built of wrought-iron columns. The piers are 50 feet long by 15 feet wide on top. There being three piers, the total length of the viaduct is 575 feet. The piers are respectively 145 feet, 252 feet, and 187 feet high. Each pier consists of 12 legs, which in plan form a rectangle. The legs are composed of a series of wrought-iron six-segment columns, in lengths of 25 feet, connections being made by cast-iron joint-boxes having tenons on each end running into the column. The columns have an exterior diameter, including flanges, of 16 inches.

The mountain-chain will be crossed at an altitude of 15,000 feet by a tunnel 3,000 feet in length. The grades are the steepest known on any ordinary railway. The workmen employed are Cholos Indians, the only operatives who can endure for a prolonged period the rarified atmosphere at this great elevation.

The subject, after this slight historical general sketch, will be considered under the headings which naturally suggest themselves, founded upon the differences in material, construction, and purpose.

See under their respective heads: —

Arched-beam bridge.
Balance-bridge.
Bascule-bridge.
Boat-bridge.
Bowstring-bridge.
Bridge-equipage.
Bridge-stone.
Bridge-train.
Cable-suspension bridge.
Canal-bridge.
Carriage-bridge.
Chain-bridge.
Check-bridge.
Chinka-bridge.
Counterpoise-bridge.
Drawbridge.
Electric bridge.
Ferry-bridge.
Fire-bridge.
Flame-bridge.
Floating-bridge.
Flying-bridge.
Foot-bridge.
Furnace-bridge.
Girder-bridge.
Half-lattice girder.
Hoist-bridge.
Hose-bridge.
Iron bridge.
Iron-arch bridge.
Lattice-bridge.
Leaf-bridge.
Lifting-bridge.
Military-bridge.
Millstone-bridge.
Pile-bridge.
Pivot-bridge.
Platform-bridge.
Ponton-bridge.
Raft-bridge.
Rolling-bridge.
Rope-bridge.
Skew-bridge.
Steel-bridge.
Stiffening-girder.
Stone-bridge.
Suspension-bridge.
Swing-bridge.
Swivel-bridge.
Tension-bridge.
Tramway for ferry-boats.
Trestle-bridge.
Truss-bridge.
Tubular-bridge.
Tubular-arch bridge.
Turn-bridge.
Viaduct.
Weigh-bridge.
Wooden bridge.

2 (*Steam.*) *a.* A lower vertical partition at the back of the grate-space of a furnace. The flame in passing the bridge is deflected upward against the bottom of the boiler.

Bridges are of metal or fire-brick. They may be hollow and form a part of the water-space of the boiler. Such are called *water-bridges.*

When a hollow water-bridge depends from the bottom of the boiler of which it forms a part, it is called a *hanging bridge*.

A bridge in the mid-space, with flue-space above and below it, is a *mid-feather*.

b. "The middle part of the fire-bars in a marine boiler, on either side of which the fires are banked." — ADMIRAL SMYTH.

3. (*Shipbuilding.*) A partial deck extending from side to side of a vessel amidships. It is common in steam-vessels, affording a convenient station for the officer in command, and extends over the space between the paddle-boxes. It is also known in England as the *hurricane*-deck or *bridge*-deck.

4. *a.* (*Metallurgy.*) The low wall of division between the fuel-chamber and hearth of a REVERBERATORY FURNACE (which see).

b. (*Puddling.*) The wall at the end of the hearth towards the stack, compelling the caloric current to ascend and then descend towards the foot of the stack.

5. (*Music.*) A bar placed beneath the strings of a musical instrument to elevate them above the sounding-board.

6. (*Ordnance.*) The pieces of timber between the transoms of a gun-carriage. (English.)

7. (*Horology.*) A piece raised in the middle and fastened at both ends to the watch-plate, and forming a bearing for one or more pivots.

When supported at one end, it is a *cock*.

8. (*Engraving.*) A board resting on end-cleats, used by an engraver to span the plate on which he is working, to support the hand clear of the plate.

9. (*Mining.*) The platform or staging by which ore, limestone, fuel, etc., are conveyed to the mouth of a smelting-furnace.

10. (*Electricity.*) A device used for measuring the resistance of an element of an electric circuit. See ELECTRIC BRIDGE.

Bridge-board. (*Carpentry.*) A notched board to which the *treads* and *risers* of a stair are fastened. A *notch-board*.

Bridge-eq'ui-page. The United States bridge-equipage is composed of two distinct trains, — the reserve and the advance-guard trains. The former is intended to accompany large bodies of troops in the field, and is provided with the material for the construction of bridges of sufficient capacity to pass large armies with their heaviest trains over rivers of any size and capacity. For these the French ponton is adapted.

The advance-guard train is intended for the use of light troops, such as advance-guards, cavalry expeditions, etc. It is organized, both as regards material and carriages, with a view to rapidity of movement. At the same time, it is capable of furnishing a bridge which will fulfill all the requirements of troops engaged on such service. For this train the canvas ponton is adapted. See PONTON-BRIDGE.

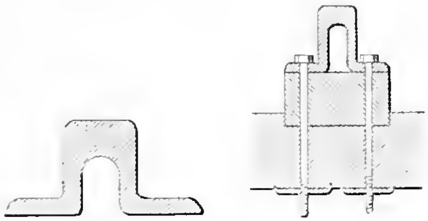
Bridge-head. (*Fortification.*) A work commanding the extremity of bridge nearest to the enemy; a *tête de pont*.

Bridge-o'ver. (*Carpentry.*) A term showing that certain parts lie across and rest on others; as, common joists, bridge-over binding-joists, etc.

Bridge-pile. (*Civil Engineering.*) A pile driven to support a timber of a bridge.

Bridge-rail. (*Railroading.*) A railroad-rail having an arched tread and lateral foot flanges. It was adopted by Brunel for the Great Western Railway

Fig. 925.



Bridge-Rail.

of England, which is excelled by none in the solidity of its track and bed. It is laid on a longitudinal sleeper in cross-ties. Felt saturated in pitch, or its equivalent, is placed beneath the rail over the sleeper, and gives a certain resiliency to the track.

The other rails are known as EDGE-RAILS and FOOT-RAILS (which see).

Bridge-stone. (*Masonry.*) A stone laid from the pavement to the entrance-door of a house, spanning a sunken area.

(*Road-making.*) A flat stone serving as a bridge across a gutter or narrow area.

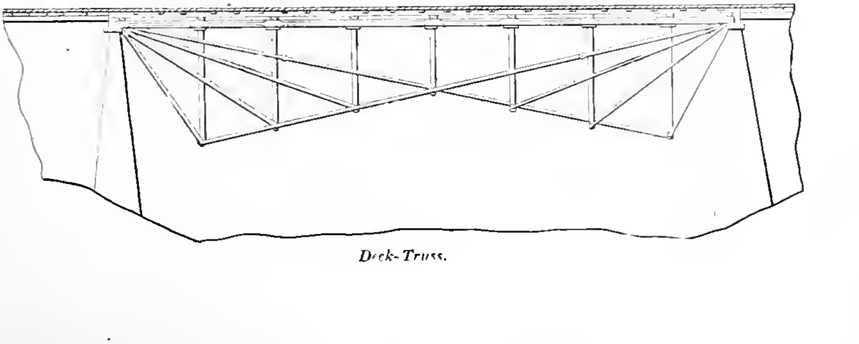
Bridge-train. A *bridge-equipment* or *ponton-train*, consisting of a military bridge composed of portable boats. See BRIDGE-EQUIPAGE; PONTON-BRIDGE.

Bridge-tree. (*Milling.*) The beam which supports the *spindle* of the *runner* in a grinding-mill. On the upper surface of the *bridge-tree* is the socket of the spindle. The bridge-tree is capable of vertical adjustment, to vary the relative distance of the grinding-surfaces, by moving the runner towards or from the bed-stone. The adjusting device is called a *lighter-screw*. See GRINDING-MILL.

Bridge-truss. A structure of thrust and tension pieces, forming a skeleton beam, in a viaduct. It has several varieties: the lattice, the arched truss, or combination of arch and truss, the deck-truss, in which the road-bed is on the straight stringers. See WOODEN BRIDGE; IRON BRIDGE.

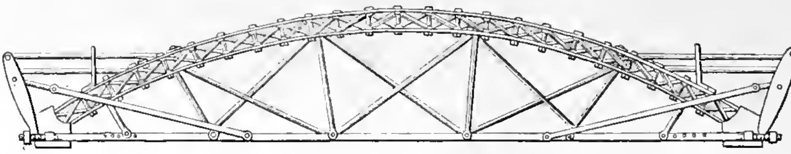
Fig. 926 shows a deck-truss in which the railway-track is laid upon the straining-beams, which are supported by posts and braces which act as tension-bars.

Fig. 926.



Deck-Truss.

Fig. 927.



Bridge-Truss.

Fig. 927 shows a trussed arch *B*, whose ends rest on skewbacks or shoes *G*. *A* represents one of the chords. *I I* are tension-straps, which act as suspension-chains to the chords, having their bearings on levers stepped in the shoes and braced against the truss by struts *N*.

Bridge-ward. (*Locksmithing.*) The main ward of a key; usually in the plane of rotation. See Key.

Bridg'ing. (*Carpentry.*) Short cross-pieces connecting adjacent floor-joists to prevent lateral deflection. See Chimney.

Single bridging has one pair of diagonal braces at the midlength of the joists. *Double bridging* consists of two pairs of cross-braces, dividing the joist into three lengths.

Bridg'ing-floor. (*Carpentry.*) A floor in which bridging-joists are used without girders.

Bridg'ing-joist. (*Building.*) A *joist* in a double floor, resting upon the *binder* or *binding-joist*, and supporting the floor. A *floor-joist*.

Bridg'ing-piece. (*Carpentry.*) A strut-piece nailed between joists or beams, to prevent lateral deflection. A *strutting* or *straining piece*.

Bri'dle. 1. (*Saddlery.*) A head-stall, bit, and bearing or riding rein, completing the head-gear of a horse's harness.

Bridles have differed in form, material, and caparisons in different nations and times, from the simple thong of the Indian to the rather preposterous bridle of the Japanese, as seen in the United States Patent Office collection. The sculptures disentombed by Layard, and the Egyptian paintings and carvings,

Fig. 928.

Assyrian Bridle (from Sculpture at Nineveh)

show patterns for the chase, for war, and for display. Except for a limited time the Jews had but few horses. This animal in those days was for show or for warfare, and the ox and ass divided the drudgery. The use and application of the bridle are, however, frequently mentioned in Scripture.

The primitive bridle was a noose around the lower jaw of the horse. In the most ancient paintings of Egypt, we find the head-equipments of the horses in full order, the bridles and bits complete.

David refers to the bit and bridle as the means of governing the horse and the ass, and Job refers to the bridle. Solomon bought his horses in Egypt, contrary to the express command of the law. He paid about $75 apiece (150 shekels). But the precious metals were relatively higher than now, in proportion to food and other necessaries.

The old Grecian bridle had somewhat similar leathers to our own. The bit was in several jointed portions. A breaking-bit for intractable horses was armed with prongs (*lupatum*, wolves' teeth).

Homer refers to the bridle and bit. Xenophon speaks of their uses and management. The last-mentioned writer refers also to the double-bridle, — a smooth snaffle-bit and a cruel spiked bit.

The Japanese bridle has a network of strings to defend the eyes from flies. The reins are of silk. The horse is usually led by a man holding the bridle near the bit, as the bridle-reins are held by grooms on each side, leaving the rider's hands free to hold on by the pummel.

The modern *bridle* of Europe and America consists of the following pieces: —

The *crown-piece.*	*Throat-latch* or *lash.*
Brow-band.	*Rein.*
Cheek-strap.	*Bit.*

Sometimes: —

Nose-band.	*Hitching-strap.*

Fig. 929 illustrates a number of bridles having checking or safety devices.

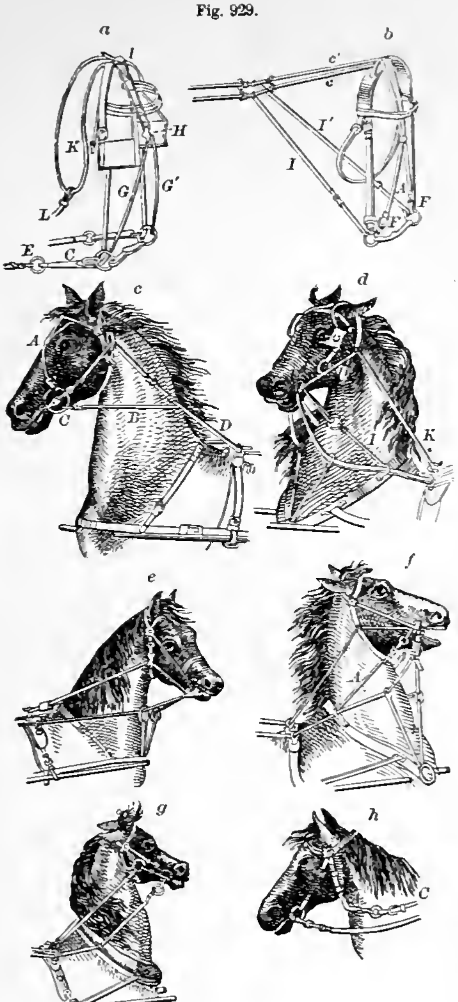
In *a* the driving-reins are attached at *E* by a gum-elastic strap and snap-hook *C* to the rings of the snaffle-bit. Face-pieces *G G'* are also attached to these rings, passing upward through the loops *H I*, and uniting to form the throat-latch *K*, to which the hitching-strap *L* is secured. The combined throat-latch and face-piece prevents the bridle slipping, as the draft upon the hitch-strap draws the ring into the angles of the mouth. In driving, a pull on the lines stretches the gum, which attaches the driving-reins to the rings of the bit, and draws upon the face-straps and throat-latch to pull the bit into the angles of the mouth.

b. Two pairs of branch-reins are attached to the ends of the driving-lines, one *I I* leading directly to the bit-rings, and the other *c c'* passing over the horse; its lower branches *A* connect with the same rings by a spiral spring within cases *F*.

c. The overdraw-strap *A* and check-rein *B* are secured to the bit-ring *C*, and the driving-rein *D* to a swivel on the bit. The driving-rein passes through a ring on the end of the overdraw-strap, and is also connected to the check-rein. A strong pull on the driving-rein throws up the horse's head and prevents him from kicking.

d. The bit-ring *F* is suspended on each side from a ring *D* on the cheek-strap by a running strap, which, connected primarily to the bit-ring, passes up and down through the check-ring; the run-

Fig. 929.



Bridles.

ning-strap is then carried down through the bit-ring and connected by a ring to a safety-rein *I*. The latter is also connected to the gag-rein *K*, so that pulling upon the safety-rein shortens the gag-rein, and at the same time draws up the bit toward the ring on the cheek-strap.

e. The driving-reins run over pulleys attached to the bit-rings and throat-latch, and thence pass to the check-hook. Stops on the cheek portion of the rein limit the length of the gag part.

f. This bridle has a safety attachment formed by supplemental reins *A* within the ordinary reins, and which, connecting directly to the cheek-straps, pass through the rings of the bit, and serve to forcibly pull the bit into the corners of the mouth.

g. The driving-rein connects with the cheek-strap, which is pulled through the bit-ring, and draws the bit up into the angle of the mouth.

h. A lever-jaw *A* on each side is suspended from the throat-latch of the bridle. The jaws are kept apart by a spring, but by pulling on the rein *C* may be brought together, so as to compress the horse's windpipe and choke him into submission.

2. (*Machinery.*) *a*. A link attachment, limiting the separation of two pieces.

Fig. 930.

Bridle.

b. Of a slide-valve; the flanges which keep it in place, and serve to guide and limit its motion.

3. (*Nautical.*) *a*. One of the ropes by which the *bowline* is fastened to the *leech* of a sail.

b. A mooring-hawser.

4. (*Husbandry.*) The piece on the forward end of a plow-beam, to which the draft-shackle is attached. The *clevis*. Also called the *muzzle* or *plow-head*. See PLOW.

5. (*Fire-arms.*) That piece in a gun-lock which serves to bind down the sear and tumbler, and prevent their lateral motion.

Bri'dle-bit. Bridle-bits are of great antiquity, as is proved by the Egyptian and Assyrian paintings and sculptures. Xenophon (400 B. C.) describes several kinds, smooth, sharp, and toothed. The curb is a modern invention, and was introduced into England from the Continent in the reign of Charles I.

The command exercised by the bit has led to the use of it in metaphor, as in a remarkable passage of James in his Epistle general: —

"Behold, we put bits in the horses' mouths that they may obey us."

Etruscan and Grecian sculpture represent the bridle substantially as we yet have it.

The Greeks had a severe bridle, armed with teeth, which came over the nose like the *cavezon*, a European bit but little known among us. Another rough bit was also known as a *lupaton*, owing to its sharp prongs like wolves' teeth.

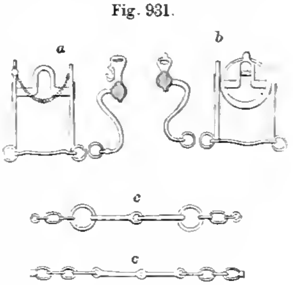
Bridle-bits may be classed under three heads: *snaffles*, *curb-bits*, and *stiff bits*.

The *snaffle* (*c*, Fig. 931) has two bars, jointed together in the middle of the mouth, and has rings at the ends for the rein. It sometimes has cheek-pieces, to keep the ring from pulling into the mouth of the animal.

The *curb-bit* consists of the following parts: —

Cheek-pieces or *branches* with eyes for the *cheek-straps* and for the reins, and holes for the curb-chain; a *mouth-piece*, uniting the *cheek-pieces* and forming the bit proper; sometimes a bar uniting the lower ends of the branches; a *curb-chain*.

Fig. 931.



Bridle-Bits.

In the Mexican bit the curb-chain and its strap are replaced by a curb-ring.

By means of the branches, a leverage is obtained upon the horse's jaw, the curb-chain behind the jaw forming the fulcrum.

The illustration shows bits employed in the United States military service.

a, ordinary curb-bit.

b, Mexican bit.

c c, watering bridle-bits or *snaffles*.

The *stiff bit* (*a*, Fig. 932) has rein-rings at the ends, and is usually without branches. It lacks the middle-joint of the *snaffle*.

b is a new form of upper-jaw bit. It is fastened by a nose-strap to the upper jaw, and buckled to the gag bearing-rein. A safety-rein passes to the usual bit-rings, and is also connected to the bearing-rein, so as to pull the usual bit back against the jaws, and the upper-jaw bit up into the angle of the mouth.

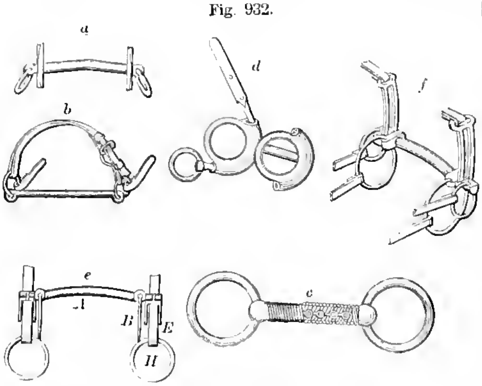
The *elastic bit* (*c*) consists of a chain covered by closely coiled wire between the bit-rings.

Another form of elastic bit is made of twisted wire with a soft rubber covering.

A large number of contrivances have been patented for giving a greater command over the horse, by means of pulling the bit upwardly into the angle of the mouth instead of pulling against the jaw. See BRIDLE.

d has tubular bit-rings through which pass the straps connecting the driving-reins to the head-stall. When the lines are pulled upon, besides drawing the bit against the jaw, the line slips through the tubu-

Fig. 932.



Bridle-Bits

lar bit-rings, and draws the stiff bit up into the angle of the mouth. The illustration shows one bit-ring empty and the other with the strap passing through it.

e has a pulley-frame swiveled to the ends of the bit *A*; the driving-reins are buckled to the rings *H*, and when they are pulled, the straps *E* run through the pulleys and draw the bit up into the angle of the mouth. The rings *B* are for the bearing-rein. As the pulley-frames are swiveled, the bit is carried upward into the mouth without turning the bit in the mouth. The pulley-frames are removable when required, so as to leave the bit in the ordinary condition.

The bit *f* is designed to effect the same purpose. One rein is connected to the bit-ring and the other to the slotted cheek-pieces; when the latter rein is pulled, the rigid bit slides up the slots and is drawn into the corners of the mouth.

Bri′dle-ca′ble. (*Nautical.*) A cable proceeding from a vessel to the middle of another cable which is moored at each end.

Bri′dle-port. (*Shipbuilding.*) A port in the bow for a main-deck chase-gun; through it mooring-bridles or bow-fasts are passed.

Bri′dle-rein. A rein passing from the hand to the bit, or from the check-hook to the bit, or, in wagon-harness, from the top of the hames to the bit.

The bridle-rein may be a *check*-rein, *gag*-rein, or a *riding-bridle* rein; the latter a *snaffle* or *curb*-rein, according to the kind of bit.

Bri-doon′. (*Saddlery.*) 1. The snaffle-bit and rein used in European military equipments in connection with a curb-bit which has its own rein.

2. In the United States the term is sometimes applied to a simple snaffle without cross-bars, and having a rein attached to its rings.

Bri′er-scythe. (*Husbandry.*) A stout, short-bladed scythe in a nearly straight handle, and used for cutting down brambles and the like.

Bri′er-tooth Saw. A saw whose interdental spaces are deeply depressed by oblique filing on alternate sides. See GULLET-SAW.

Brig. (*Nautical.*) A two-masted vessel, square-rigged on both masts. It has a gaff-sail on each lower mast; that on the mainmast is called the driver. When the driver is bent to rings on a try-sail mast, just abaft the mainmast, the vessel was formerly called a *snow*.

A hermaphrodite brig is a vessel rigged as a *brig* on the foremast and like a *schooner* on the mainmast, carrying *square* sails forward and *fore-and-aft* sails abaft.

Brig′an-tine. (*Nautical.*) A two-masted vessel brig-rigged on the foremast, but having no lower square sail on the after or mainmast.

Bril′liant. 1. (*Diamond-cutting.*) A mode of cutting gems, consisting of lozenge-shaped facets alternating with triangles. The variations are known as the *half brilliant*, *full brilliant*, *split* or *trap brilliant*, *double brilliant* or *Lisbon cut*. See CUTTING GEMS.

A diamond cut as a brilliant has two truncated portions, respectively above and below the *girdle*, which is at the largest circumference. The upper portion, which projects from the setting, is called the *bizet*, and is one third of the whole depth of the gem. The remaining two-thirds is imbedded, and is called the *culasse*. The facets of the bizet and the culasse have consequently different inclinations and exhibit different figures, as will be apparent from the illustrations.

A well-cut brilliant, held in a beam of light, reflects nearly the whole of the light which falls upon it, throwing it out and refracting it in colored rays through the facets in front. With the exception of one small point of light through the *collet*, the brilliant throws an opaque shadow on a screen.

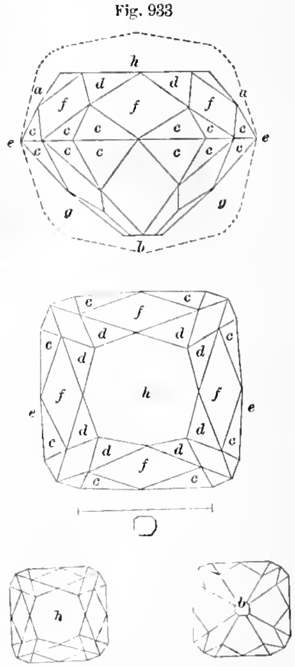
a. *Bizet*; the chamfered portion of the stone between the *table* and the *girdle*.

b. *Collet*; the horizontal face at the bottom of the stone.

Facet; small, triangular faces.

c. *Skew* or *skill facets*; divided into *upper* and *under*, and respectively wrought upon the *bizet* and *pavilion*, in each case terminating in the *girdle*.

Fig. 933



Brilliant.

d. *Star-facets*; wrought on the bizet, and terminating in the *table*.

e. *Girdle*; the line encompassing the stone; its outer edge by which it is grasped in mounting.

f. *Lozenges*; rhombal facets formed on the bizet by the *star* and *skill facets*.

g. Pavilion; the chamfered portion of the stone between the *girdle* and *collet.*

h. Table; the horizontal face at the top of the brilliant.

2. (*Printing.*) A very small type, smaller than Diamond.

Pearl.
Diamond.
Brilliant.

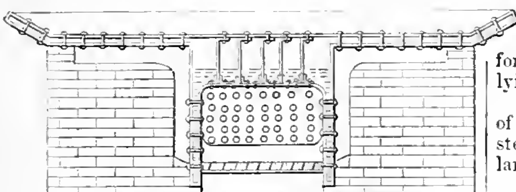
3. (*Fabric.*) A cotton goods woven with a small raised pattern, and printed or plain.

4. (*Pyrotechny.*) A form of pyrotechnics for making a bright light. The filling is gunpowder 16 and steel-filings 4; or, gunpowder 16, borings 6.

Brin. One of the radiating sticks of a fan, from 12 to 24 in number and about 14 inches long. The outermost are larger and longer, and are called *panaches.*

Brine-e-vap'o-ra-tor. An apparatus for evaporating brine, in order to produce salt. The common furnaces for this purpose have a row of pans set

Fig. 934.



Platt's Brine-Evaporator.

above a long arch; shelving sides hold the salt as it is dipped out, and allow it to drain into the kettles. In the illustration the pan bottom is double, forming a steam-jacket; the multiflue boiler forms a jacket around the fuel-chamber. The flame and heat, after direct passage through the flues, pass backwardly alongside the furnace-jacket and beneath the steam-jacket of the pan.

The following United States patents may be consulted: —

Guiteau	1842.	Garrison	1862.
Hull	1855.	Hull	1863.
Humphreys	1856.	Farrar	1863.
Heims	1859.	Platt	1869.
Pratt	1862.	Gilson	1870.
Chapin	1862.	Howarth	1871.

Brine-pump. (*Steam-Engine.*) A pump worked by the engines to withdraw the super-salted water from the boilers mechanically, instead of by periodical blowing off.

Maudslay and Field's English Patent, 1824, describes a brine-pump with a loaded discharge-valve worked by the engine, and so proportioned as to draw from the lower part of the boiler the quantity determined on, which may be regulated by a meter, showing the quantity driven off in the form of steam. After the boiler has been in action some time, and the water has received a predetermined degree of concentration, the brine-pump is started to work, and every stroke takes from the boiler as much salt as is deposited in the boiler by the separation of the steam used in that stroke. The hot brine so withdrawn is used to heat the boiler-supply.

Brine-valve. (*Steam.*) A valve which is opened to allow water saturated with salt to escape from the boiler. A *blow-off* valve.

Bring'ing-to Bolt. One used in keying up a structure. It may be a *screw* or a forelock bolt.

Bring'ing-up. (*Printing.*) The operation of overlaying, underlaying, cutting out, etc., for equalizing the impression or giving the proper prominence to the dark and light parts of woodcuts.

Bris'tle. Bristles for brush-making are assorted according to color.

Washed with potash-lye and soap, to free them from animal fat.

Whitened by bleaching them with fumes of brimstone.

Combed with a steel comb, to lay them parallel and remove the short hair with which they may be mixed.

Sorted by continually pulling out the longer hairs from the bunch, butting the end of the bunch on the bench.

Bound in bunches called *knots,* which are inserted in the bored holes in the brush-backs, and tied and glued in position.

The face-ends of the bunches are then sheared.

Machines are in use, and some patented for —

Assorting bristles.	Cleaning bristles.
Bunching bristles.	Washing bristles.

Bris'tol-board. (*Paper.*) A superior article of cardboard, in which all the sheets of paper composing it are white, and erasures may therefore be made without exposing an inferior underlying quality. See Cardboard.

Bris'tol-brick. A brick composed principally of granular silicious matter. Used for polishing steel, etc. The name is derived from Bristol, England, near which city they are made.

Bris'ure. (*Fortification.*) A break in the general direction of the parapet of the curtain, when constructed with *orillons* and retired flanks.

Brit-an'nia-met'al. A white-metal alloy, resembling silver in some degree, and used for making table-ware, etc.

There are several formulas for compounding this white alloy for table-ware: —

	Copper.	Tin.	Antimony.	Bismuth.	Brass.	Zinc.
Lardner's	8	392	28		8	
Overman's	3	88	7			1
Another	1	1	2			
Another		4	4	4	4	
Another	2	100		2	8	

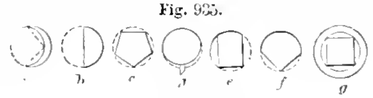
See *ante,* White-Metal Alloys, p. 63.

Brit'ish-gum. An adhesive material, used by calico-printers, and made by scorching potato-starch.

Britz'ska. (*Vehicle.*) A Russian carriage, having a calash top and interior arrangements adapted for use as a couch on long journeys.

Broach. 1. A tapering steel tool, of prismatic form, and whose edges are used for reaming out holes. It is particularly used by watchmakers in enlarging holes in watch-plates. When smooth, it is

Fig. 935.



Broaches.

no longer a broach, but a burnisher, and is used for burnishing pivot-holes. The number of sides vary; the smaller the number, the more salient is the edge.

Broaches are also used by dentists for enlarging the nerve canals of the teeth for the insertion of the dowel-pins which secure *pivot-teeth.*

The end of a broach has as many facets as the shaft has sides, and the tang is 4-sided.

a is the carpenter's broach for reaming out holes in wood. The angle of its edges would be inadmissible in metal as hard as copper.

b is a half-round broach. The edges are rectangular.

c has five sides with angles of 108°.

d has but two facets and an inserted steel cutter at their angle.

e has angles of 90°, and but three facets; the rounded back follows the circle of the hole.

f has one angle of 90°.

g represents the gun-barrel broach of four sides; slips or spills of segmental form occupying the spaces between the rectangular broach and the circumscribing cylinder.

Broaches of 3, 4, 5, 6, 8 sides have respectively angles of 60°, 90°, 108°, 120°, and 135°. The polygonal broaches are the most commonly used.

Broaches twisted while hot have an increased energy of bite, when rotated in the direction of the spiral, and less when rotated in the other direction.

ROBERTS's broach (English) has longitudinal cutters inserted in grooves at each angle.

Some *broaches* have file teeth to enable them to cut with a thrust, without rotation. These are more properly *drifts* (which see).

A round broach is used for burnishing pivot-holes.

2. A gimlet used in opening casks for samples. The hole is closed by a spile.

3. (*Candle-making.*) The stick from which candle-wicks are suspended for dipping.

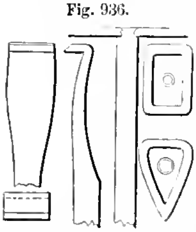
4. (*Husbandry.*) A sharpened stake used by thatchers to secure the gavels or layers of straw.

5. (*Locksmithing.*) That pin in a lock which enters the barrel of the key.

Broach-post. (*Carpentry.*) A *king-post.*

Broad. (*Wood-turning.*) A bent turning-tool, or one formed of a disk, with sharpened edges secured to a stem. Used for turning down the insides and bottoms of cylinders in the lathe. Fig. 936 shows several different forms of the tool, — the bottom-tool, hook-tool, square-tool, heart-shaped tool.

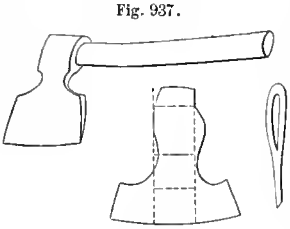
Fig. 936.



Broad.

Broad-axe. An axe with a broad edge, for hewing timber. The chamfer of the edge is all on one side, the flat side of the bit going against the wood. The handle has a crook, so that the knuckles are not grazed against the timber when hewing.

Fig. 937.



Broad-axe.

The Israelites west of the Jordan had but small advantages of timber, and were not skillful hewers. They imported axemen and timber. Lebanon had cedar and fir; Bashan had oak. The kings of Syria and Egypt fought for their possession for centuries. Even firewood was scarce in Judea and Samaria. The poor widows gathered a bundle of sticks then as now.

Dung and hay used for heating ovens, Ezekiel iv. 12-15, Matt. vi. 30.

Brushwood also, — "as the crackling of thorns under a pot," etc.

Broad'cast Sow'er. (*Husbandry.*) A machine which spreads the seed regularly upon the surface of the ground, in contradistinction to a drill which sows the seed in rows.

Number of several seeds in a bushel, and number per square foot upon an area of an acre: —

	Number.	Square Foot.
Timothy	41,823,360	960
Clover	16,400,960	376
Rye	888,390	20.4
Wheat	556,290	12.8

The Egyptians and Romans sowed from a basket. In the West we prefer a bag or sack which is made into a pouch by tying the bag-string to one corner of the bottom. Pliny mentions that it is important for the action of the hand and feet to keep time, to secure an even spread of the seed. It is just so with us. A right-handed man will dip his hand into the bag for seed just as his left foot touches the ground. Some sow with both hands.

Under the Romans, the amount of seed to the *jugerum* (four fifths of an acre) was, of wheat, spelt, and barley, respectively, 5, 10, and 6 *modii.* A *modius* was two gallons.

Broad'cloth. (*Fabric.*) A wide and superior article of woolen cloth, plain or twilled, and dyed in the wool or the piece. A cloth not over 29 inches broad is a *narrow* cloth. It is folded lengthwise in the piece.

The operations in broadcloth-making may be shortly cited as follows: —

The wool, being shorn, goes to the sorter, who selects the grades and parts of fleeces adapted for this superior kind of goods.

Oiled, carded, and spun into yarn.

Woven into a web of such a width as to permit subsequent shrinkage.

Felted by wetting, soaping to remove grease, and pounding. The effect is to condense it and shrink it in width and length. After removal of the soap by fuller's earth, water, and pounding, the web is dried by stretching on tenter-bars.

Napped on a gigging-machine, which raises the nap by the little recurved spires of the teasel (*dipsacus fullonum*).

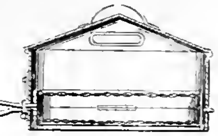
Shorn to bring the naps to a length.

Hot-pressed to give smoothness and polish.

Broad-gage. (*Railway Engineering.*) A distance between rails over 56½ inches. The width of 4 feet 8½ inches was adopted by Stephenson, being the usual grade of the coal-wagons on the railways in the North of England. He found it, did not make it. Brunel, who was not used to following anybody, either under or above ground, struck out a path for himself, and gave the broad-gage to the Great Western Railway of England, making it 7 feet. It was a very expensive experiment, and has been reduced to the standard of 56½ inches. See RAILWAY-GAGE.

Broad-glass. Glass in large sheets for cutting into *lights* or *panes.* For very many years, the mode of making sheet-glass was by forming a disk, which was united to the blowing-tube by a boss, around which point the glass was also much thicker than at other portions, especially near the periphery of the disk. See CROWN-GLASS. Owing to the vexatious excise laws of England, it was almost impossible to introduce improvements in the manufacture of glass, as was illustrated in the abortive attempts of the English opticians to manufacture lenses of large sizes, even under semi-official sanction. The general relaxation of the excise system under Sir Robert Peel's Act of 1846, rendered possible the introduction into England of an improved method, for some time then past in use in France and Belgium. The glass used upon the Exhibition Building of 1851 was made upon this plan, which is briefly as follows: —

The workman dips his iron tube into the semiviscid glass, and takes up a quantity amounting to 12 or 14 lbs.; he rolls the mass on a wooden block, till it assumes a cylindrical shape; he applies his mouth to the other end of the tube, and blows until the mass assumes a hollow ovoid form; he whirls this round his head, or, rather, in a vertical circle 10 or 12 feet in diameter, and elongates the ovoid into a cylinder with round ends; he re-heats the glass two or three times during these processes, to maintain the proper consistency, and at length the remote end of the hollow mass gives way, and we have before us a cylinder of glass, attached only at one end to the tube. The cylinders are dissevered from the tube, and are cut lengthwise with a diamond; they are placed in a kiln, where the heat gradually opens the fissure, and there is finally presented a flat piece of glass, which can be cut to any smaller size.



This glass is called *broad-glass*, *cylinder-glass*, *sheet-glass*, and by several other names of minor usefulness, value, or appropriateness. See CYLINDER-GLASS.

Broad-horn. The old-fashioned term for the flat-boat of the Western and Southwestern rivers. Also called an *ark*.

Broad-pen'nant. (*Nautical.*) A square piece of bunting carried at the mast-head of a vessel having in command an officer of a certain rank. In the British and American navies it signifies a commodore's vessel.

Broad'side. 1. (*Printing.*) A sheet of paper printed on one side, the matter forming a single page.

2. (*Nautical.*) *a.* The side of a ship, above the water, from the bow to the quarter.

b. All the guns, collectively, carried on one side of a war vessel.

Broad'sword. A sword with a broad blade, designed principally for cutting.

Broad'stone. (*Masonry.*) An ashlar.

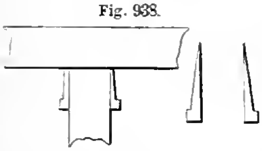
Broad-tool. 1. (*Masonry.*) A stone-mason's chisel which has an edge 3½ inches wide. It is used for finish-dressing. The previous tools are the *point* or *punch*, *inch-tool*, and *boaster* (two inches wide).

2. (*Turning.*) A BROAD (which see).

Broad Win'dow-glass. Glass blown of a cylindrical form, split longitudinally, and spread flat. See BROAD-GLASS; CYLINDER-GLASS.

Brob. (*Carpentry.*) A peculiar form of spike driven alongside a timber which makes a butt-joint against another, to prevent the slipping of the former. For instance, several *brobs* are driven round a post which supports a roof-timber in a tunnel or gallery.

Fig. 938.



Brob.

Bro-cade'. (*Fabric.*) A rich, stout silk. A common name for any kind of stuff wrought and enriched with raised flowers. In the East, a cloth of gold and silk. The manufacture of brocade was established at Lyons, in 1757.

Bro-ca-telle'. (*Masonry.*) A kind of marble whose color is a mixture of gray, yellow, red, and dove shades.

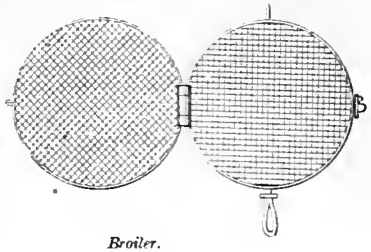
Bro-ca-tel'lo. (*Fabric.*) A coarse brocade of cotton, or silk and cotton.

Bro-ché-goods. (*Fabric.*) Goods embroidered or embossed.

Brog. A joiner's awl.

Broil'er. (*Domestic.*) A gridiron. The later devices have provision for turning the grids so as to expose each side of the meat alternately to the action of the fire.

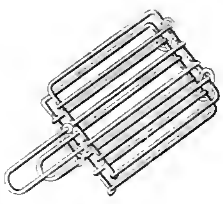
Fig. 939.



Broiler.

In the upper example the gridiron is made in two parts, hinged together, and so that it may revolve and expose both sides of the meat, which can be examined during the cooking process by means of a transparently-covered opening in the top of the case. The grids are pivoted within a covered case.

Fig 940.



Broiler.

In the other example it is simply a double frame with means for locking together.

Brok'en-space Saw. A fine hand-saw.

Brok'en Twill. (*Fabric.*) A variety of *twill* in textile fabrics.

Bron'cho-tome. (*Surgical.*) A knife used in the operation of cutting into the *bronchus*, or windpipe. Asclepiades, who lived at the beginning of the first century B. C., proposed the operation of bronchotomy, though it is not certain that he performed it.

It was practiced three hundred years afterward by Antyllus, and was particularly described by Paulus Æguieta about A. D. 780.

Bron'tern. A brazen vessel in the basement below a stage, to imitate thunder.

Bronze. 1. An alloy composed of copper and tin, sometimes with a little zinc and lead. The "Big-Ben" bell of Westminster, the largest bell in England, is composed of 22 parts copper, 2 parts tin. Gun-metal is a bronze, 9 parts copper, 1 of tin. It is probable that some of the ancient alloys which we read of as "brass" were really bronze. The Phœnicians brought tin from Cornwall 1100 B. C., before the building of Solomon's Temple. See BRASS.

"Tarshish was thy merchant [Tyre]; with silver, iron, tin, and lead they traded in thy fairs."

The tin of Cornwall, and also probably that from the peninsula of Malacca, was mixed with the copper of the Wady Maghara to form the Egyptian, Phœnician, and Assyrian bronzes. Dr. Wilson (*Prehistoric Man*) supposes that tin was first brought to the Mediterranean from Malacca, and gave a new impetus to early Eastern civilization. Britain was the next source. Chili and Mexico are more lately known as productive sources of the same useful metal.

The ordinary Assyrian bronze is composed of copper 10, tin 1. Their bell-metal was, copper 86, tin 14.

The ancient bronze cutting-tools contained from 4 to 15 per cent of tin, from which it is gathered that the secret of their manufacture is rather in their mode of working and tempering than in their composition. This appears to be also the case with Chinese cymbals and tam-tams, whose tones are not rivaled by the instruments made by European artists, though analysis of the alloy fails to disclose any reason for this. Bronze, containing 20 per cent of tin, is brittle at the ordinary temperature, becomes malleable at a dull red heat. See ANNEALING.

Bronze is the oldest alloy with which we are acquainted, and is assumed to have preceded the use of iron in the majority of countries which have passed through the various stages. It is not a violent assumption that the stone and bone implement age preceded the age of copper tools; that the latter was the first metal which was used in the mechanic arts; that the alloying of copper with tin to harden it preceded the use of iron (see ALLOY); that brass (copper and zinc) was a discovery later than either (see BRASS); that the first iron utilized was of the nature of steel, as yet produced in many countries of Europe, Asia, and Africa by the native metallurgists. In speaking of ages, no general world-wide area of contemporary progress is intended. There are tribes yet in the bone age (see AXE), others in the bronze. Some of the bone men have jumped into the iron (which they purchase) because they had no copper, and iron was the first metal with which they became acquainted; such are some of the South Sea Islanders.

Hesiod, 900 B. C., states that iron was discovered after copper and tin, and that those who were ancient, in his day, used bronze. Lucretius mentions also the gradation: —

> "The primeval arms were the hands, the nails, and the teeth,
> Together with stones and branches, the fragments of the forests;
> Afterwards was found the power of iron and of bronze,
> But the use of bronze was known before that of iron."

Bronze implements are obtained by casting, and, it is believed, by subsequent hammering while hot. (See *supra*.) Bronze and copper were cast in ancient Egypt; the Chinese state that Yu, who was semi-king with a partner (Chun) on the throne of China, 2200 B. C., caused nine vases to be cast, on which were engraved maps of the nine provinces of the Empire. The Greeks, Etruscans, and the pupils of the latter, the Romans, excelled in the art; and the museums of Europe have almost numberless specimens of their art in statuary, household utensils, and ornaments. When the Spaniards first entered the province of Tuspan, they mistook the bright copper or bronze axes of the natives for gold, and were greatly mortified, after they had accumulated them in considerable numbers, to discover the mistake they had made. Bernal Diaz narrates that "each Indian had, besides his ornaments of gold, a copper axe, which was very highly polished, with the handle curiously carved, as if to serve equally for an ornament as for the field of battle. We first thought these axes were made of an inferior kind of gold; we therefore commenced taking them in exchange, and in the space of two days had collected more than six hundred; with which we were no less rejoiced, as long as we were ignorant of their real value, than the Indians with our glass beads."

Ancient American Bronzes.	Copper.	Tin.	Iron.
Chisel from silver-mines, Cuzco	94	6	
Chisel from Cuzco	92.385	7.615	
Knife from grave, Atacama	97 87	2.13	
Knife	96	4	
Crowbar from Chili	92 385	7.615	
Knife from Amaro	95.664	3.965	0.371
Perforated axe	96	4	
Personal ornament, Truigilla	95.440	4.560	
Bodkin from grave	96.70	3.30	

The bronzes of Europe took a much wider range of variation.

	Copper.	Tin.	Lead.	Iron.
Spear-head, Lincolnshire	86	14		
Bronze vessel, Cambridgeshire	88	12		
Flexible nails	20	1		
Sword, France	87.47	12.53		
Medal	100	8 – 12		
Axe-head, Mid-Lothian	88.5	11.12	0.78	
Caldron, Duddingstone	84.8	7.19	8.53	
Mirrors	100	30 – 50		
Sword, Ireland	83.50	5.15	8.35	3
Sword, Thames	89.69	9 58		0.33
Axe-head, Ireland	89 33	9.19		0.33
Drinking-horn, Kings Co., Ireland	79.34	10.87	9.11	
Wedge, Ireland	94	5.9		0.1

See also Brasses and Bronzes, with the addition of Iron, p. 61.

	Copper.	Tin.	Zinc.	Lead.	Arsenic.	Iron.	Aluminium.
Statuary bronze	91.4	1.4	5.5	1.7			
Church bells	80	10.1	5.6	4.3			
Church bells	16	3 – 5					
Clock bells	72	26.5				1.5	
Gun-metal	9	1					
Gongs	81.6	18.4					
Cymbals	4	1					
Lathe-bushes	80	20					
Machinery bearings	7	1					
Machinery bearings, hard	77.4	15.6	7				
Speculum metal	66	22			12		
Speculum metal	7	4	3				
Speculum metal	50	29	21				
Speculum metal	6	2		1			
Speculum metal (Lord Rosse)	126.4	58.9					
Aluminium bronze	90						10

Cooley's recipes for bronze: —

	Copper.	Tin.	Zinc.	Lead.
For edge-tools	100	14		
For gilding	82	3	18	2
For medals	89	8	3	
For medals (M. Chaudet)	95	4		
For mortars	93	2		5
For statuary	88	9	2	1
Or (Statue, Louis XV.)	82½	5	10½	2
Or	91	9		

Alloys into which aluminium enters, either in combination with copper alone, or with that and other metals, are usually termed aluminium bronzes; the composition of some of these is given below: —

	English Patent, 2,768 of 1862.	English Patent, 3,159 of 1862	English Patent, 42 of 1863.	English Patent, 2,285 of 1867.	Minargeot.	Gold-colored.	Hard white.	Malleable white.	Hard bronze.	Non-oxidizable	Baur's, 1863.	Paris gold-colored.
Aluminium	7.5	7.5	13.70	10	1	1	100	2	10	25	3	10.5
Iron			27.18							75		
Copper	92.	90	31.71	100	100	10		10	90		16	89.3
Platinum			98.84									
Tin			58 92									
Nickel			29.62	70	70							
Silver			108 30				5					
Zinc			32.31								10	
Gold		2.5										
Tungsten				5	5							

See also Aluminium Bronze, pp. 70, 71.

2. (*Cotton-manufacture.*) One style of calico-printing, peculiar rather from the character of its colors, than from any specific novelty in treatment.

Bronze Pow'der. Finely pulverized metal, or powder having a metallic base, applied to the surface of paper, leather, and other materials, for imparting a metallic color and luster.

1. *Gold powder* for bronzing is made by grinding leaf-gold with honey; dissolving the mixture to obtain the gold by deposition, the honey water being decanted.

2. *German gold* is a yellow-alloy leaf similarly treated.

3. *Mosaic gold* is prepared by incorporating and grinding tin, 16; flower of sulphur, 7; mercury, 8; and sal-ammoniac, 8; and then subliming the amalgam. A flaky gold-colored powder remains in the matrass.

4. *Copper powder* is obtained by saturating nitrous acid with copper, and then precipitating the copper by exposing iron bars in the solution.

5. Bisulphide of tin. It has a golden luster, flaky texture, and is used for ornamental work, such as paper-hangings, and as a substitute for gold-leaf.

6. Dutch foil reduced to a powder by grinding.

7. Verdigris, 8; tutty powder, 4; borax, 2; niter, 2; bichloride of mercury, $\frac{1}{2}$; grind into a paste with oil, and fuse them together.

8. (Iron-colored) plumbago in powder.

9. (Red) sulp. copper, 100; carb. soda, 60; mix and incorporate by heat; cool, powder, and add copper filings, 15; mix; keep at a white heat for twenty minutes; cool, powder, wash, and dry.

Bronz'ing. The process of giving a bronze-like or antique-metallic appearance to the surface of metals.

The processes vary; they may be classed as —

Coating with a melted alloy.

Coating with a metal in paste, solution, or vapor.

Corrosion.

Coating with a gum.

Application of bronze powder.

Painting.

The modes vary with the material: —

I. As to copper (some of them applicable to brass).

1. The surface is cleaned, polished, and a paste of crocus powder and water applied to it. Apply heat to develop the color required.

2. Plumbago applied in the same manner. By employing mixtures of plumbago and crocus, different shades are obtained.

3. The copper is exposed at a high heat to the fumes of zinc.

4. The copper vessel is filled with a water acidulated with hydrochloric acid, an amalgam of zinc and cream of tartar being added. Boil for a while.

The latter two processes are more properly *brassing.*

5. Corrosion processes: —

a. Wash the cleaned copper with a dilute solution of sulphuret of potassium, or hydrosulphuret of ammonia is applied with a brush.

b. Apply solution of verdigris, 2; sal-ammoniac, 1; and vinegar, 16.

c. Or, verdigris, 2; vermilion, 2; alum, 5; sal-ammoniac, 5; vinegar sufficient to form a thin paste. Blue vitriol inclines to dark brown, borax to yellow brown.

d. Or, sal-ammoniac, 1; cream tartar, 3; common salt, 3; hot water, 16; dissolve, and add nitrate of copper, 3, dissolved in water, 8; apply repeatedly with a brush.

e. Or, salt of sorel, 1; sal-ammoniac, 3; distilled vinegar, 32; apply as above.

f. Or, a weak solution of chloride of platinium.

II. As to iron: —

a. Clean the metal, and wash it with or immerse it in a solution of sulphate of copper or verdigris, when it will acquire a coating of copper.

b. The metal may be dipped in molten metal, copper, or its alloys.

c. The polished metal — a gun-barrel, for instance — may be dropped in a solution of chloride of antimony and sulphate of copper. This is *browning.*

d. The ordinary solution consists of: aquafortis, 1; sweet spirits of niter, 1; blue vitriol, 4; tincture of the muriate of iron, 2; water, 32.

e. Or, blue vitriol, 1; sweet spirits of niter, 1; water, 16.

f. The iron is cleaned, polished, coated with linseed-oil, and heated to develop the tint required. Tucker's patent, Dec. 15, 1863.

g. The iron is cleaned, polished, and lacquered. The lacquer consists of shell-lac in alcohol, with or without the addition of saffron, annotto, aloes, or other coloring substances.

h. The iron is painted with a *gold*-paint, so called; Dutch metal and varnish.

i. The iron is painted green, and rubbed with bronze powder.

III. As to tin: —

Clean the castings, and wash them with a mixture of 1 part each of sulphate of copper and sulphate of iron in 20 parts of water; dry and wash again with a solution of verdigris, 5 parts; in distilled vinegar, 11 parts. When dry, polish with colcothar.

IV. As to plaster: —

Plaster-of-paris statuettes, medals, etc., may be bronzed in the following manner: —

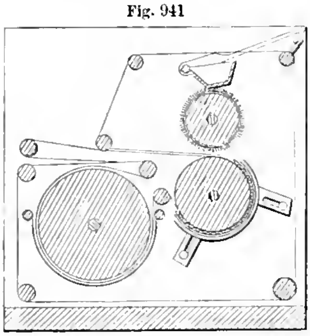
Prepare a soap from linseed-oil boiled with caustic soda lye, to which add a solution of common salt; and concentrate it by boiling, till it becomes somewhat granular upon the surface; it is then strained through a linen cloth, and what passes through is diluted with boiling water, and again filtered. Dissolve 4 parts of blue vitriol and 1 part of copperas separately in hot water, and add this solution to the solution of soap as long as it occasions any precipitate. This flocculent precipitate is a combination of the oxides of copper and iron with the margaric acid of the soap, the former giving a green and the latter a reddish-brown color, the combination of the two resembling that greenish rust which is characteristic of ancient bronzes. When the precipitate is completely separated, a fresh portion of the vitriol solution is to be poured upon it in a copper pan, and boiled in order to wash it. After some time the liquid part is poured off, and the soap washed with warm and afterward with cold water, pressed in a linen bag, and drained and dried, when it is ready for use, in the following manner: —

Three pounds of pure linseed-oil are boiled with 12 ounces of finely powdered litharge, and the mixture is strained through a canvas cloth and permitted to stand in a warm place until it becomes clear. 15 ounces of this, 12 ounces of the above-described soap, and 5 ounces of fine white wax, are melted together at a gentle heat in a porcelain basin, by means of a water-bath. The mixture must be kept some time in a molten state, to expel any moisture which it may contain. It is then applied by means of a paint-brush to the surface of the gypsum, which is heated to the temperature of about 200° F. After exposure to the air for a few days the surface is rubbed with cotton-wool or a fine rag, and variegated with a few streaks of metal powder or shell gold. Small objects may be dipped in the melted mixture and then exposed to the heat of the fire until thoroughly penetrated and evenly coated with it.

The bronze letters and figures upon the bonds and paper currency of the United States — as, for instance, "the faint attempt at a *metallic ring*," as Mr. Secretary Chase called it, on the old twenty-five-cent fractional currency — are made by printing in drying-oil, and applying the metal in fine dust to the damp surface.

Bronz'ing-ma-chine'. A machine for bronzing wall-papers or printed sheets. Those parts of the sheet which are to receive the bronze powder are first printed with letters or figures in ink or size. The machines vary in the special devices for distributing and removing superfluous powder.

Fig. 941

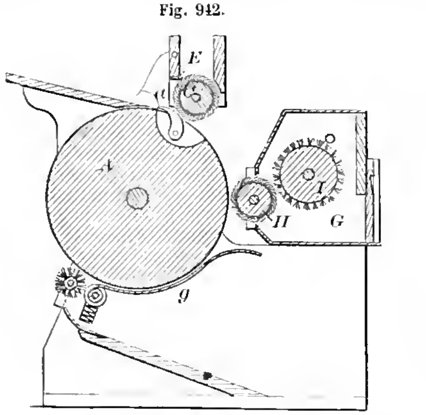


Bronzing-Machine.

In Fig. 941 the freshly printed paper is carried between endless tapes under a fur-covered roller, through a fur-lined box, and around a roller beneath a wiper-apron. It operates by first coating the freshly inked parts with bronze-dust, and then removing the same from between the letters.

In the example (Fig. 942) the freshly printed paper is laid upon the feed-braid, and its edge seized by the gripper *a*, so that the revolution of the wheel *A* carries the sheet past the fur-wheel *C*, which revolves at the bottom of the bronze-hopper *E;* thence past the burnisher *H*, which removes superfluous bronze, and is itself cleaned by the brush *I*, which delivers the bronze into the collecting-box *G*. The sheet then passes between the wheel *A* and apron *g*, and receives a final brushing at the point of delivery.

Fig. 942.



Bronzing-Machine.

Brooch. 1. An ornamental clasp with a pin for fastening the dress.

The term corresponds to *ouch* (which see), under which name the ornamental clasp appears in the King James version of the Bible, Exodus xxviii. 11, xxxix. 18, and in other places. See Minshieu's "Ductor in Linguas," 1617; Phillips's "World of Words," 1658. See also the same passages in the "Bishop's" and "Coverdale's" versions. In the "Wickliffe" version it is rendered "hookes."

The *ouch* or *brooch* was a clasp or button, and, in course of time, came to be fastened with a pin called a *broach* (Fr. *broche*), and hence the name *brooch*, of this form of ornamental clasp, has been attributed to the name of the pin (*broach*) by which it is fastened.

This brooch or pin, probably as large as the corking-pin of Swift's time, of old formed a stiletto upon occasion, as among the Athenian dames, who made such pointed inquiries of the man who alone escaped from the slaughter of the party of Athenians who made a raid upon Egina, to capture the olive-wood statues of Damia and Auxesia, plundered by the Eginetans from the Epidaurians. Herodotus, V. 87, says: —

"When he came back to Athens, bringing word of the calamity, the wives of those who had been sent out on the expedition took it sorely to heart that he alone should have survived the slaughter; they therefore crowded around the man, and struck him with the brooches by which their dresses were fastened, each, as she struck, asking him, 'Where did you leave my husband?' and the man died in this way."

The upshot of it was, that the men of Athens were so disgusted at the conduct of the women, that they changed their dress, which was a short Dorian tunic having no sleeves, and fastened over both shoulders by brooches, and compelled them to wear the Ionic linen gown, with short, loose sleeves, and with a skirt reaching to the ankles. "This," Herodotus says, "does not require brooches."

This brooch was not a buckle, but a pin with a hooked head; so it was a broach, after all.

2. A painting all of one color, as in sepia or india-ink.

Brood. (*Mining.*) Any heterogeneous mixture among tin or copper ore; as, mundick, black-jack, etc.

Broom. A domestic utensil for sweeping, made of various materials, most commonly, with us, of the broom-corn, which is a species of doura or sorghum, and came from Africa. Of late years much attention has been directed to the subject of broom-heads, so that, instead of the handle and head being thrown away as useless when the corn is worn out, they are made permanent, with arrangements for clamping the corn and unclamping it, so that it may be removed when worn out, and fresh corn substituted.

Benjamin Franklin introduced broom-corn into this country, previous to which brooms were made of evergreen boughs. It is said that, while examining an imported corn-whisk, he discovered a single seed, which he planted in his garden, and from which the corn was propagated.

Brooms are, however, made of various materials, animal and vegetable.

Among the kinds may be cited (and some of them are really brushes on long handles): —

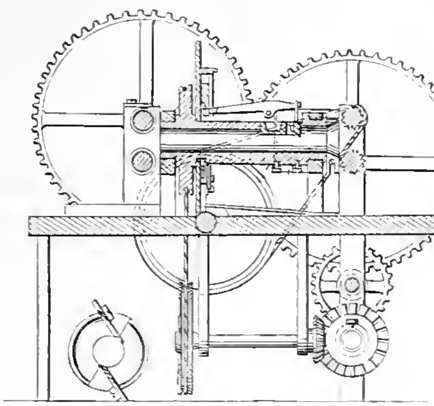
Carpet.	Hearth.
Coir.	Hickory.
Hair.	Whisks.

Broom-corn Seed-strip'per. A machine like a flax-*ripple*, for removing the seeds from broom-corn. It is like a comb, over which the corn-brush is thrown, and the seeds stripped off by pulling the brush between the teeth.

Broom-han'dle Ma-chine'. A lathe with a hollow mandrel and internal cutters. The stick is passed longitudinally through the mandrel and rounded throughout its length.

In the example the hollow mandrel has a pair of circular cutters for cutting off the rough corners of the handle ; also a tapering bit oscillating on a pivot and acted on by a spring, a lever being connected with the cutter by a link, and the bit being con-

Fig. 943.



Broom-Handle Lathe

trolled by plates connected with catches, projections resting on the flanges of the cam-wheels attached to a shaft, there being, farther on the mandrel, a third beveled cutter, with its cutting-edge flatwise thereto, so that by their movements the various work is effected.

Broom-head. A clasp or cap for holding the bunch of broom-corn, so that a worn stump may be removed and fresh brush substituted. There are very many forms, among which may be cited the examples annexed, which require but little explanation.

In the upper left-hand example the broom-corn is hung over the stirrup and drawn into the cap by the screwing of the stirrup into the handle.

The next figure shows another stirrup, screw-shank, and cap arrangement.

The figure beneath the one last described has a head whose bars have prongs to enter the bunches of brush. The bars of one side open to admit the broom-corn, and are then locked in closed position.

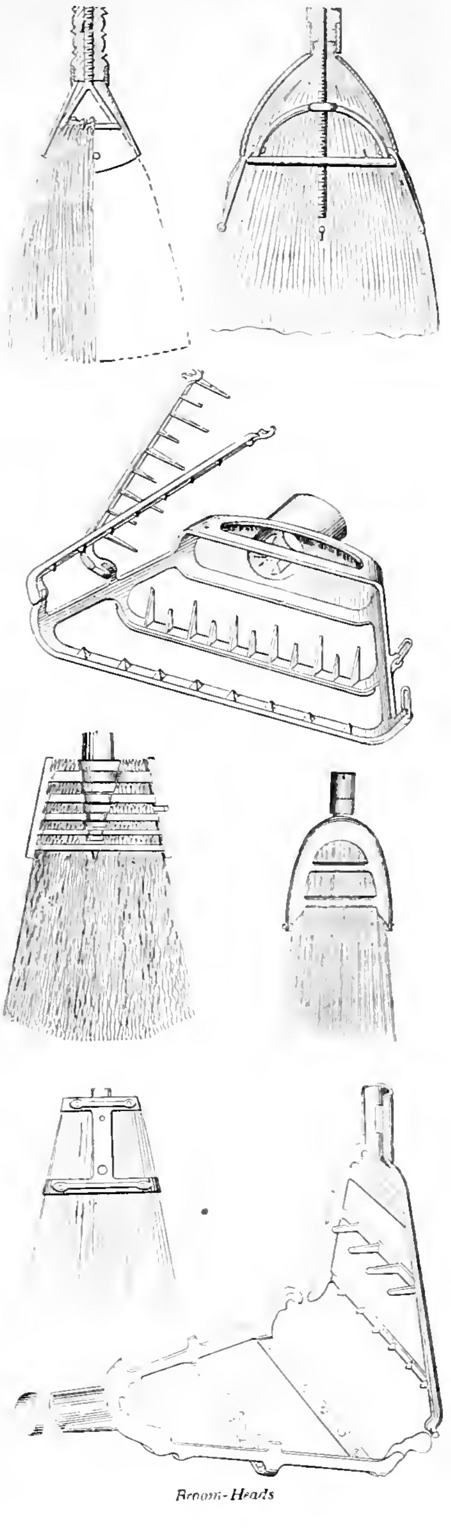
The next examples have variously shaped heads and modes of securing the contents.

The lower figure has a clasp with a pair of hinged jaws with pronged bars.

Broom-sew′ing Ma-chine′. A machine for pressing a bunch of broom-corn into shape for a broom, and sewing it in its flattened form. The broom is placed between jaws *a a*, closed by an eccentric *c*, operated by lever *b*.

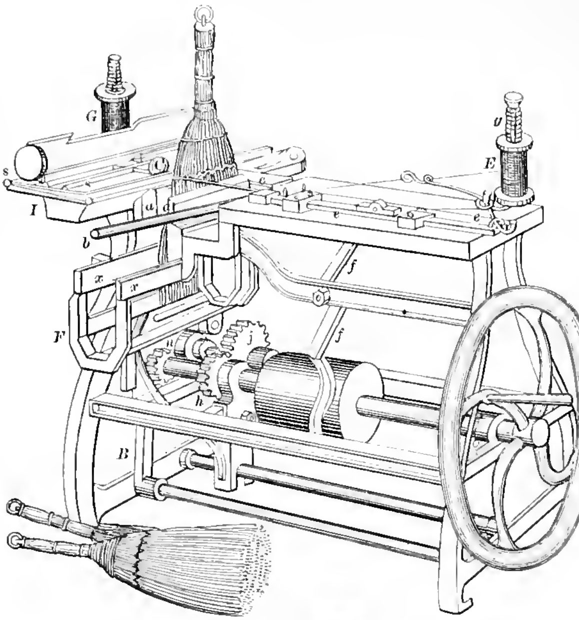
The machine being set in motion by the rotation of the shaft of the cam-wheel *A*, the cam-groove of the latter, actuating the lever *f*, forces forward the needle-bar *e*, thus driving the needle with its thread through the broom above the twine wound around the latter. The shuttle *C*, operated by lever *B*, acting on the opposite side of the broom in conjunction with the needle, forms the stitch. This being done, the reverse movement of the needle-bar withdraws the needle, the eccentric *n* lifts the jaws *a*, so that the next stroke of the needle carries the stitch below the binding-twine, the jaws being meanwhile moved along the guides *x* by means of a pawl, operated by

Fig. 944.



Broom-Heads

Fig. 945



Broom-Sewing Machine.

a cam *n* on a supplemental shaft moved by gears *h j*, the pawl gearing with a ratchet formed at the under side of the outermost of the jaws *a*. The next outward movement of the needle, the jaws being, of course, again lowered, carries the stitch above the binding-twine. In this manner the stitches are formed alternately above and below the binding-twine, the distance apart of the stitches corresponding, of course, to the intermittent feed given, as just described, to the jaws *a* upon their supporting-guides *x*. The needle is supplied from spool *E*, which has a tension-spring *g*.

Brough'am. (*Vehicle.*) From *brouette*, a form of fiacre invented by Dupin about 1671. A closed carriage with a single inside seat for two persons, and an elevated driver's seat. The front is glazed, and the fore-wheels turn on a short lock.

Brow-band. (*Saddlery.*) A band of a bridle, head-stall, or halter, which passes in front of the horse's forehead, and has loops at its ends, through which pass the cheek-straps.

Brown'ing. A process by which the surfaces of articles of iron acquire a shining brown luster; this may be produced by chloride of antimony.

Browning, or Bronzing Liquid. Sulphate of copper, 1 oz.; sweet spirit of niter, 1 oz.; water, 1 pint. Mix. In a few days it will be fit for use.

Browning for Gun-Barrels. Tinct. of mur. of iron, 1 oz.; nitric ether, 1 oz.; sulph. of copper, 4 scruples; rain-water, 1 pint. If the process is to be hurried, add 2 or 3 grains of oxymuriate of mercury.

When the barrel is finished, let it remain a short time in lime-water, to neutralize any acid which may have penetrated; then rub it well with an iron wire scratch-brush.

Another recipe is: —

Nitric ether	6 ounces.
Alcohol	1 ounce.
Sulphate of copper	1½ ounces.
Muriated tinct. of iron	1½ ounces.
Tinct. of gum benzoin	1½ ounces.
Water	3 pints.

The blue vitriol is first dissolved in the water (boiling).

Brown Pa'per. A coarse kind of wrapping-paper, which is made from unbleached material, such as junk, hemp, refuse flax, etc. It is made of various qualities, from *manilla* to *straw*.

Brown Ware. A common variety of pottery, named from its color.

Brow-post. (*Carpentry.*) A beam that goes across a building.

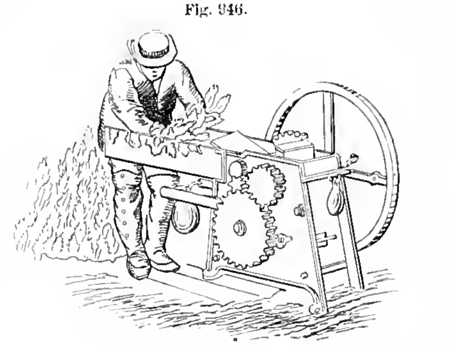
Bruis'er. A concave tool used in grinding lenses or the speculums of telescopes.

Bruis'ing. (*Leather-manufacture.*) After curried leather has been *daubed* and *dried*, it is *grained* by folding *grain*-side in, and rubbing with a *crippler*. It is then extended and rubbed on the grain-side, which is called *bruising*.

Bruis'ing-ma-chine'. A machine for bruising rough feed to make it more palatable and digestible for stock. It is principally used in Britain in bruising prickly plants such as the furze, which is also known as *whin* or *gorse* (*Ulex Europeus*),—a prickly plant very common in the British Islands, and very nutritious when brought into a condition which does not repel the animals.

The mode of preparing it, where machinery is not accessible, is by means of the chopping-block and mallet.

Fig. 946.



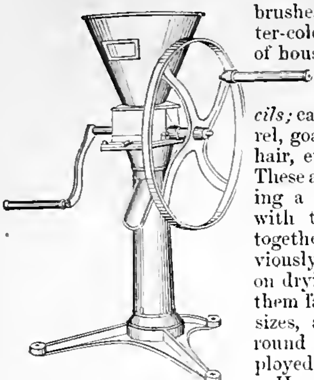
Furze-Bruising.

The illustration shows a bruising-machine with studded cylinders.

Bruis'ing-mill. (*Milling.*) A hand-mill in which grain for feed, malt for brewing, and flax-seed for pressing, are coarsely ground. It consists of two cast-iron rollers mounted on a strong frame, and so arranged that grain is carried between them and crushed more or less according to the degree to which the rollers are tightened up by the hand-screw at the end of the frame. With the hand-mill one man will crush about 2½ bushels of oats or flax-seed per hour, and two men 4 bushels. By horse or steam power it will crush from 15 to 24 bushels per hour. Of malt, from two to three times the above quantities may be ground. (Fig. 947.)

Brush. 1. An assemblage of hairs, hog's bristles, strips of whalebone, short wires, fastened to a handle, either collectively or in separate tufts.

Fig. 947.



Bruising-Mill.

The smallest kind of brushes are used in water-color, and some kinds of house, sign, and coach painting, and are called *pencils;* camel, badger, squirrel, goat, fitch, and sable hair, etc., are employed. These are made by inserting a tuft of the hairs with their roots bound together into a quill previously softened, which, on drying, serves to hold them fast; for the larger sizes, a tin tube, either round or flat, is employed.

Hogs' bristles are, however, the material principally used, the whiter and better kinds being employed for hair, tooth, clothes, and hat brushes, and also for the better classes of paint-brushes.

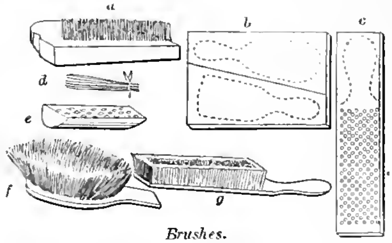
The bristles are first sorted according to color, and then, by means of a series of combs (*a*, Fig. 948), having teeth formed of needles of various sizes, and placed at different distances apart, they are assorted according to size, by employing at first the largest comb and then in succession the smaller ones, fixed to a work-table.

The paint-brush — the simplest form of brush — is made by inserting full-length bristles between two projecting prongs on the handle, and securing them by a wrapping of twine, which is afterward protected by a coating of glue mixed with red-lead. In other paint-brushes the bristles are surrounded by a metallic cap, which binds them to the handle. In large paint-brushes and painter's dusters, the handle is secured by driving its smaller end foremost into the bristles, placed within an iron cup, which binds them fast.

Hair-brooms, dusters, etc., are made by inserting tufts of bristles into a stock or head previously bored with holes for their reception. These are frequently bored angularly to the face, or the face itself is rounded so as to give the tufts an outward splay when inserted; the root-ends are first dipped into melted pitch, then bound with thread, again dipped, and then inserted with a sort of twisting motion. Brushes of this description are usually made with bristles of the full length; but where stiffness is required, as in scrubbing, hair, and other similar brushes, each tuft of bristles is doubled so as to present both ends outward; these are then cut off square and even, presenting a hard surface, especially when the doubling is made near the root-ends.

The stocks or brush-boards are cut from pieces of requisite thickness, so as to get two out of each width of board (*b*, Fig. 948). The holes are drilled through a pattern-board, to insure uniformity; this is flat for a plane-surface brush, but if the edge is to have oblique rows of bristles, a pattern bent to a corresponding obliquity is employed. *Drawing*, the next step, is performed by clamping the drilled stock to a table and passing a loop of brass wire through the first hole in the first row, inserting a tuft of bristles through the loop and drawing on the wire, so as to pull the tuft into place, when, bending the wire again, another loop is formed, and so on successively until a row is completed, when the tufts are cut off with shears to a length regulated by a gage; or, in case the bristles are short, the stock is filled previous to cutting. In Fig. 948, *c* shows a perforated brush-back, *d* a tuft ready for insertion, *f* the face of an oval brush after drawing, and *g* a brush of black bristles with an edging of white bristles, cut and finished.

Fig. 948.



Brushes.

The drawing-wires are neatly covered with veneer to strengthen and improve the brush, and prevent the wires from scratching the hand; after which the brush is finished up with a spoke-shave and scraper, sand-papered, and varnished. In the smaller kinds of drawn brushes, such as nail and tooth brushes, the holes are sunk in narrow grooves in the stock, which are afterwards filled with a hard red cement.

The best sorts of brushes are *trepanned;* in this process a number of holes are drilled in the bone back either transversely or longitudinally, and a number of holes are sunk through to these from the face-side of the brush; the tufts are then drawn with strong thread or silk, and the longitudinal or transverse holes filled with plugs of bone or ivory.

Whalebone, cut into strips, and split, is used in the same manner as bristles, to form brushes, either by itself or in conjunction with bristles. In the latter case, the adulteration is soon detected by the more rapid wear and splitting of the ends of the whalebone.

In Woodbury's brush-making machine a quantity of the bristles is laid upon a comb-shaped feeder, and a steel point parts from their edge, as spread upon the apron, just enough for one bunch. A plunger comes down upon this bunch and bends it double, the two halves fitting into slots in a follower in size suited to the work in hand. A carrier then pushes about two inches of wire through the bunch at the bend, and cuts off the part thus advanced. The plunger now pushes the doubled bunch with wire down into a nut with spiral threads or rifles on the inside, at the same time giving it a twist. The effect of this motion is to wrap the wire as a spiral or screw thread around the bunch, and the twisting or gimlet motion continues so as to screw the bunch, wire and all, into the hole of the brush-stock below, giving it the firmness and solidity of a screw. Then releasing its hold and giving one revolution backward, to take the twist out of the bunch, the plunger flies up and is ready for another bunch, which it prepares and inserts by the same motions. This set of operations is completed at the rate of about 70 series per minute, thus finishing an ordinary scrubbing-brush within that time. As the holes do not pass through the wood, no back is required.

Among the varieties and parts of brushes, and the appliances concerned in their making, may be named: —

Blacking-brush.	Bristle-bunching machine.
Black-lead brush.	Bristle-cleaning machine.
Bottle-brush.	Bristle-washing machine.
Brass-finisher's brush.	Broom.
Bristle-assorting machine.	Brush-back.

Brush for cannon.	Horse-brush.
Brush-handle.	Hydraulic-brush.
Brush-head.	Irrigating-brush.
Brushing-machine.	Lure.
Brush-making machine.	Marking-brush.
Carpet-brush.	Mechanical broom.
Carriage-brush.	Nail-brush.
Cloth-brush.	Paint-brush.
Clothes-brush.	Paste-brush.
Drawn-brush.	Revolving-brush.
Dusting-brush.	Rotary-brush.
Ear-brush.	Scrubbing-brush.
Engine-brush.	Shoe-brush.
Feather-brush.	Spoke-brush.
Flesh-brush.	Stock-brush.
Flue-brush.	Street-sweeping machine.
Furniture-brush.	Tar-brush.
Graining-brush.	Tool-brush.
Hair-brush.	Tooth-brush.
Hair-pencil.	Tube-brush.
Harness-brush.	Velvet-brush.
Hat-brush.	Whisk-brush.
Hearth-brush.	Wire-brush.

2. A mop for cannon. See SPONGE.

Brush-hat. One in which the surface is continually brushed by a hand-brush, during the process of sizing, so as to bring a nap to the surface.

Brush'ing-ma-chine'. 1. (*Hat-making.*) A machine for brushing hats, to remove the dust after pouncing, or to lay the nap smoothly.

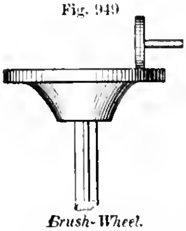
2. (*Woolen-manufacture.*) A machine used to lay the nap on cloth before *shearing*. It has a cylinder covered with brushes. For some purposes, the cloth is damped by exposure to steam, which escapes in minute jets from a copper box extending the whole width of the machine. Sometimes called a *brushing-mill.*

3. (*Flax-manufacture.*) A machine for scutching flax, in which the beaters are superseded by stiff brushes of whalebone. See SCUTCHING-MACHINE.

Brush-pull'er. (*Agriculture.*) A machine for pulling up brush by the roots. It sometimes consists of a mere hand-tool, with a gripper to give a firmer hold than the hand will readily afford. As a machine, it is a traveling implement with closing jaws, which seize the bushes and pull them out as the team moves on.

Brush-wheel. *a.* A wheel with bristles on its periphery, used to turn another wheel. One of the wheels being driven, communicates motion to the other by frictional contact. The contacting surface may be a brush, leather, india-rubber, cloth, or anything else which is slightly elastic and not too slippery. The relative rate of motion may be adjusted by moving the wheel whose periphery is engaged towards or from the center of the face-wheel. The motion may be communicated by contact of the peripheries of the respective wheels.

Fig. 949



Brush-Wheel.

b. A circular brush running in a lathe, and used to polish articles, is also called a brush-wheel.

These brushes are hard or soft, and the wheels are from two to eight inches in diameter.

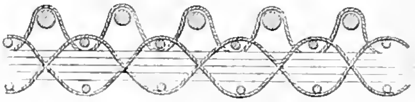
They are used with emery, putty-powder, rottenstone, crocus, rouge, etc., and other kinds of polishing-powder, with oil or dry. They are especially useful in chased, indented, carved, and open work.

The brushes are generally of bristles, but sometimes of wire.

Brus'sels Car'pet. A carpet having a heavy linen web, inclosed in worsted yarns of different colors, raised into loops to form the pattern. The ordinary Brussels carpet has an uncut pile. In the *imperial* Brussels the figure is raised above the ground and its pile is cut, but the ground is uncut.

In the illustration the small dots represent the ends of the linen weft-threads; the double waving lines the linen warp-threads; the five lines inclosed between the linen warp and weft represent the worsted yarn which is pulled upon to form loops over the wires, which are represented in the figure by the larger dots, and are subsequently withdrawn.

Fig. 950

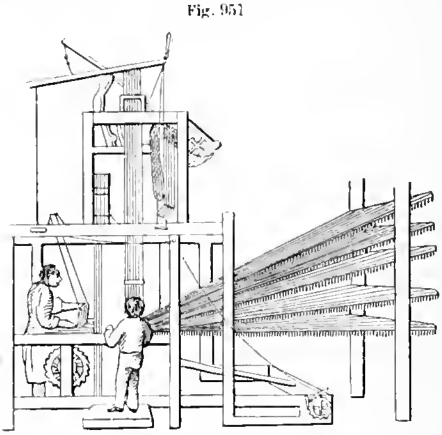


Brussels Carpet.

The pattern is formed by bringing to the surface, at any particular spot, such one of the colored yarns as is required, and they are formed into loops by being turned over wires. As the yarns are taken up very unequally, they are not wound upon a yarn-beam, but are separately wound upon bobbins arranged on frames at the back of the loom, a small leaden weight being attached to each bobbin to give it the required tension.

In the *Brussels-carpet loom* there are as many frames as there are colors, and the number of bobbins is regulated by the width of the carpet. With ¾-yard-wide carpet there are 260 bobbins to a frame, but when the carpet is one yard wide, each frame will have 344 bobbins. The warp-yarn from each bobbin is termed an *end;* this may consist of one, two, or three threads, according to the quality of the carpet. The *ends* are carried through small brass eyes, called *mails*, attached to fine cords, one eye and one end for each cord. Each cord is passed over a pulley fixed above the loom, and is fastened to a stick. For a ¾ carpet there are 1,300 *mails*, cords, and pulleys to each loom. Those cords which will raise to the surface a certain set of yarns required for one row in the pattern are bound together into a *lash.*

Fig. 951



Brussels-Carpet Loom.

One *lash* is necessary for every set or row of colors that has to be drawn to the surface, and the *lashes* are taken in regular succession till the pattern is complete.

The number of lashes required will depend upon the number of weft-threads which occur in the regular recurrence of a complete pattern. If the pattern be a yard long, it may require as many as 320 *lashes*. The lashes are pulled by a boy who is called the *drawer*, in the manner of the DRAW-LOOM (which see). Like the latter, the arrangement described has been superseded to some extent by the *jacquard* attachment.

In operation, the first lash being pulled raises one fifth of the yarns, their colors being such as go to form the commencement of the pattern. A light wooden board termed a *sword* is set up on edge beneath the raised *ends*. The *lash* is let go; a round wire is inserted in the *bosom*, or opening formed by the sword, which is then withdrawn. The weaver then depresses a treadle which works the *heddles* and crosses the linen warps, and depresses all the worsted ends except those looped over the wire. The shuttle with a linen weft is then thrown; the other treadle is depressed, which crosses the warps, again locking the linen weft and raising the worsted ends. Having thrown another linen weft-thread, and driven all home against the *web* by the batten, he repeats the process, the *drawer* pulling on the second lash and so on. When a number of wires are thus employed, the ones farthest from the batten may be withdrawn and used over again. Sixty wires form a set.

In making *Wilton* or *pile carpet* the wires are flattened and have a groove on top, acting as a director for the knife which cuts the row of loops and releases the wire.

The quality of *Brussels* and *Wilton carpets* is estimated by the number of wires to the inch. The usual number for *Brussels* is nine, and for *Wilton* ten. In either fabric great care is requisite in beating up evenly, or the pattern would not match when the breadths were joined together at the sides. A bell rings when 64, 80, or 90 *lashes* have been woven, and then the weaver tests by a measure whether the required number of lashes measures ¼ of a yard. If too short, he repeats the last lash; if too long, he omits it.

As the five ends run throughout the yarn while only one of the five is taken up on an average at each *lash*, it has been attempted to dye the yarn in places, so as to make one set of ends fill the various colors of the pattern. See PRINTED CARPET.

Brus'sels Lace. *Brussels point* has the network made by the pillow and bobbins.

Brussels ground has a hexagonal mesh, formed by plaiting and twisting four flaxen threads to a perpendicular line of mesh.

Brussels wire-ground is of silk. The meshes are partly straight and partly arched.

The pattern in each case is worked on with a needle after the mesh is completed.

Bub. A substitute for yeast, employed by the distiller. Prepared by mixing meal or flour with a little yeast in a quantity of warm wort and water.

Bub'ble. The glass spirit-tube of a level.

One of the small hollow beads, or floating globes, for testing the strength of spirits by the rate at which they rise in the liquor. Now superseded by the *alcoholmeter*.

Bub'ble-tri'er. An instrument for testing the delicacy and accuracy of the tubes for holding the spirit in leveling-instruments.

The tube is charged with spirit all but a bubble of air, and is tried on its different sides to ascertain on which side the bubble moves most regularly. The stage of the *bubble-trier* has a micrometer screw for its adjustment.

Bu-cen'taur. (*Vessel.*) The state barge of Venice.

Buck. (*Masonry.*) 1. To break ore into fragments with a hammer, crusher, or grinder. This is subsequent to the operations of *spalling*, *cobbing*, and *sorting*.

2. A frame of two crotches to hold a stick while being cross-cut. See BUCK-SAW.

Buck-board. (*Vehicle.*) A plank bolted to the hind axle and to a bolster on the fore axle, being a cheap substitute for a bed, coupling, and springs.

Buck'et. 1. A vessel of wood, leather, metal, or other suitable material, provided with a handle, and adapted for containing liquids or solid materials, as in carrying or hoisting.

The ordinary wooden bucket is of pine or cedar, and holds 2½ gallons.

The bucket for hoisting is metal-bound, and sometimes is equal in capacity to a cask of 100 gallons. A *corf*.

In mining, square boxes with falling bottoms are known as *dumping*-buckets. When having sides which open when a latch is withdrawn, they are *tilting*-buckets.

On shipboard, buckets kept for emergencies in case of fire, etc., are frequently of tarred or waxed canvas or of leather. Watering-buckets for horses are, in the United States military service, made of stout, untarred canvas, and also of sole-leather, strengthened by a copper rim at top and bottom connected by side strips.

Previous to the general introduction of water-mains and fire-plugs, leathern fire-buckets were in common use. The spectators, always numerous on occasions of fire, were formed in two lines, one of which passed the full buckets from hand to hand, for supplying the engine, and the other passed the empty ones back to be replenished. Some of these relics of the past may yet be seen in old warehouses, etc.

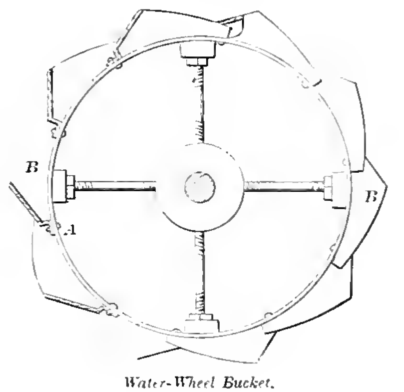
2. (*Water-wheel.*) The *vane* or *float* of a water-wheel.

The *shrouding* of a water-wheel consists of annular plates at the periphery, which form the sides of the bucket: the bucket-*ends*, in fact, but constituting a part of the *sides* of the wheel.

A *radial* bucket is one which has the bottom in a right line, continuous with the radius of the wheel.

The lower piece of a bucket is the *bottom* or *floor*.

Fig. 952.



Water-Wheel Bucket.

The outer piece is the *arm* or *wrist*. The junction of the *bottom* and *arm* is the *elbow*.

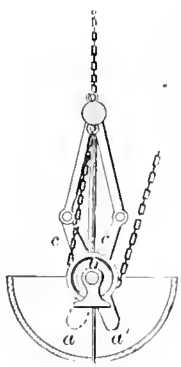
The *bucket-pitch* is a circular line passing through the elbows of the series of buckets.

In the illustration (Fig. 952), the buckets *B* are each shaped of a single piece of metal, and they are fastened consecutively on the rim *A*, which is continuous and forms the inner side of each bucket.

The buckets *B* on the left-hand side of the wheel are in section, and show the shape of the interior.

3. (*Hydraulic Engineering.*) The scoop of a dredging-machine, usually having a hinged bottom, which is closed while raising mud, etc., from the bottom, and opened to deposit the load. That illustrated is of semi-cylindrical shape, and formed in two sections, *a a'*. These are separated when the bucket is lowered down into the mud, and drawn together by the toggle-levers *c c* at the moment of raising.

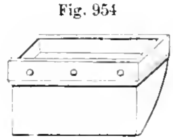
Fig. 953.



Dredge-Bucket.

4. A cup of sheet-metal, or

Fig. 954


Elevator-Bucket.

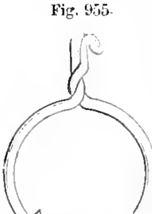
one having a metallic mouth, forming one of a series fixed to the endless band of a grain-elevator. The grain is scooped up at the lowest position of the bucket and discharged on passing the highest, as in a chain elevator-bucket pump.

5. (*Nautical.*) A globe of hoops covered with canvas, used as a recall-signal for whale-boats.

Buck'et-en'gine. (*Hydraulic Engineering.*) A machine to utilize a stream of water which has considerable fall and but moderate quantity. It consists of a series of buckets attached to an endless chain which runs over sprocket-wheels, from one or both of which power is obtained. The water flows into each bucket after passing the summit, and is discharged as each bucket reaches the lowest part of its course.

Buck'et-hook. (*Husbandry.*) A device for holding a bucket against a tree while catching sugar-maple sap. It may be driven into the tree, or may have a pair of expansible arms which embrace the tree.

Fig. 955.


Bucket-Hook.

Buck'et-mak'ing Ma-chine'. Several machines may be included under this general title.

A lathe whose hollow chuck holds the staves, which are embraced by a truss-hoop, while the inside is turned out and the rim turned off smoothly. Being then turned end about, and put upon a conico-frustal chuck, the outside is turned smooth, the lower edge turned off, and the croze made.

The piece to form the bottom is fastened to a face-plate, and turned off smooth and circular, the edge being feathered to fit the croze.

Another form of bucket-machine is one which cuts up a conical frustum of wood, so that a series of annular conical pieces are cut out of the solid, the pieces forming a nest of bucket-sides fitting within each other, and only minus the wood which was removed in making the saw-kerf.

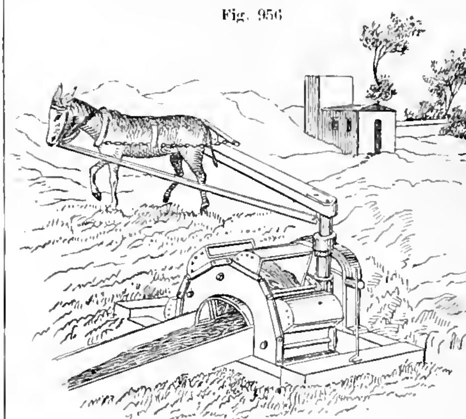
The block is placed upon a table whose angle with the horizontal is such as to make vertical that side of the bucket-block on which the band-saw is working.

Buck'et-valve. (*Steam-engine.*) The valve on the top of the *air-pump* bucket. It rises as the bucket plunges into the water in the cistern beneath, and closes as the said bucket rises to discharge its load through the *delivery-valve*.

In marine engines a flat metallic plate governs the passage between the air-pump and condenser.

Buck'et-wheel. (*Hydraulic Engineering.*) A very ancient form of water-raising device, having a

Fig. 956

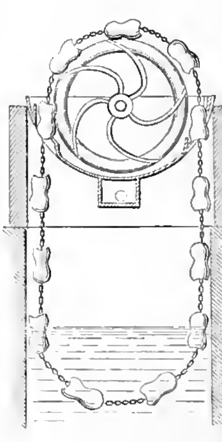

Bucket-Wheel.

wheel over which passes a rope having pots or buckets which dip into the water of the well and discharge at the surface.

In another form the pots are attached to the wheel and dip the water of a river, which they discharge into an elevated trough. See NORIA.

The illustration shows a wheel as used in Syria, India, Egypt, etc., but made in modern style by the Giours. The buckets are made of galvanized iron, and an ass walking 1½ miles an hour — Syrian gait — will raise 3,120 gallons per hour from a depth of 20 feet.

Fig. 957.


Bucket-Wheel.

In one form of water-elevator the buckets are small, and constitute links in a chain; the more common form is disks or buttons on a chain rising through a tube and thus carrying up the water.

The bucket-wheel is used in grain-elevators. See BUCKET. Also in *Carburetors*.

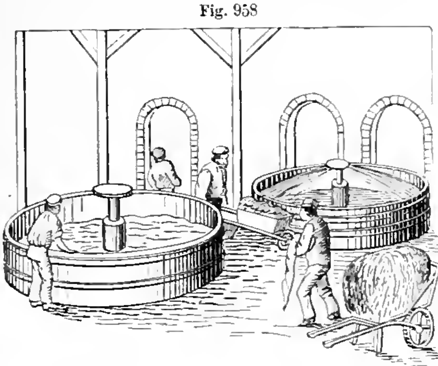
Buck'ing. 1. (*Cotton-manufacture.*) Soaking cloth in lye, as a part of the process of bleaching, alternating with *crofting*, or exposing on the grass to air and light. See BUCKING-KIER.

2. (*Mining.*) Breaking up the ore by hammers. The tool is called the *bucking-iron*, and the bench is the *bucking-plate*.

Buck'ing-i'ron. (*Mining.*) The miner's hammer, used in breaking up masses of ore.

Buck'ing-keir. (*Cotton-manufacture.*) Linen or cotton cloth is cleansed of the dirt and grease contracted in spinning and weaving, by boiling it with lime in a pan which is heated below. The

Fig. 958



Bucking-Keir.

goods rest on a false bottom, and the pressure of the steam evolved raises the water in the central column and ejects it from the edge of the circular cap in a stream upon the upper surface of the goods, through which it filters, to be again discharged as before.

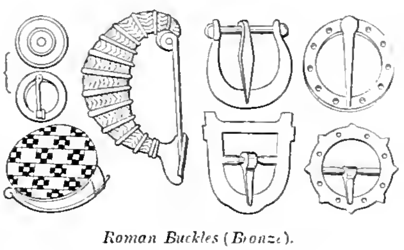
Buck'ing-plate. (*Mining.*) The miner's table on which ore is broken.

Buck'le. 1. (*Saddlery, etc.*) A device with a frame and tongue for securing straps, etc.

Buckles of brass, having circular rims and a tongue, are found in the British barrows or tumuli.

The annexed figure represents Roman bronze buckles now in the British Museum. They were worn by

Fig. 959.



Roman Buckles (Bronze).

women and men, to fasten their scarfs, shawls, cloaks, belts, etc. We read of them in Homer, Euripides, Herodotus, and elsewhere. See BROOCH.

Shoe-buckles were introduced into England during the reign of Charles II. (1670). These, as well as knee-buckles, were generally made of silver, — sometimes of gold, — adorned with precious stones, but are now disused, except as ceremonial or uniform dresses in some parts of Europe.

The principal use of buckles is for fastening the different straps of harness and horse equipments, for which purpose immense numbers are made, forming a considerable branch of trade, of which Birmingham is the metropolis.

Much the greater part of harness-buckles are either japanned or plated, the former being used for wagon, cart, and the commoner kinds of harness generally; and the latter for carriage-harness.

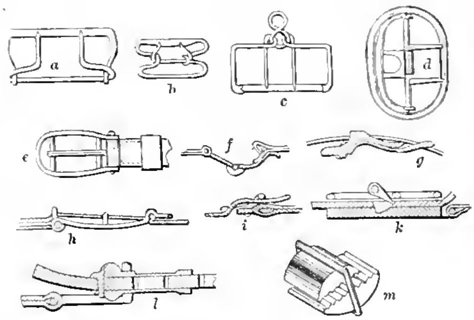
The plating material is usually brass, though many silver-plated buckles are manufactured.

Buckles are also made of bright malleable iron, and of blued iron; the latter are the kind employed in horse equipments for the cavalry in the United States Service.

Buckles are divided into bar-buckles and roller-buckles, the only difference being that the latter have a thin metallic tube around the bar opposite the tongue, which, by its revolution, facilitates the passage of the strap.

a (Fig. 960) has a wire passed through the ends of the loop and bent ends to form tongues. *b* has a bent wire embracing the waist of the loop. *c*, the recurved ends of the loop form the tongue. *d* has a tongue and pressure-bar on one crossbar. *e* is a tug-

Fig. 960.



Buckles.

buckle. *f* is a buckle in which the strap is pinched between a pivoted bar and the lip of the frame. In *g* the strap is pinched between the two parts of the frame, which are pivoted together. *h* has a number of projections, which fit corresponding holes in the strap. *i* is a skate-strap buckle, in which the tongue can be loosened from the strap by lifting the rear end of the buckle. *k* is a tug-buckle, in which the tongue is vibrated by means of a cam. *l* has a pair of metallic jaws and a tongue extending across them. *m* has a pair of serrated-faced blocks which are pinched together by the strain on the strap.

2. A permanent distortion or *kink* in a saw-blade, or a bulge which mars the flatness of a sheet-metal plate.

3. (*Saw.*) The iron loop by which a mill-saw is attached to the straining-frame or *sash*.

Buck'le-chape. (*Saddlery.*) The part by which the buckle is secured to the band.

Buck'led Plates. (*Building.*) A form of iron plates for flooring, having a slight convexity in the middle and a flat rim round the edge, called the *fillet*. They are usually square or oblong, and are laid upon iron beams or girders, convexity upward.

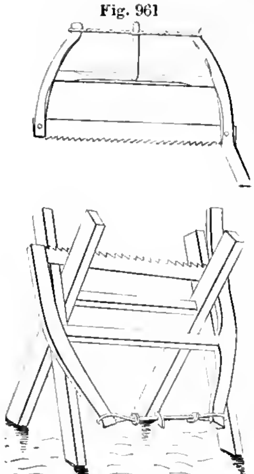
Buck'ler. (*Nautical.*) *a*. A block of wood made to fit in the hawse-hole, or hole in the half-ports, when at sea.

b. The lower half of a divided port lid or shutter.

Buck'ram. (*Fabric.*) A coarse fabric of linen or hemp, stiffened with glue, and placed in coats and other garments to hold them in shape.

This was not the material worn by Falstaff's "two rogues in *buckram* suits." See BARRACAN.

Fig. 961



Buck and Buck-Saw.

Buck-saw. A frame-saw with one extended bar to form a handle, and adapted to a nearly vertical motion, in cross-cutting wood held by a saw-buck.

Buck'shot. A kind of leaden shot, larger than swan-shot, used in hunting large game, and formerly for the military service. Those formerly employed for making musket-cartridges weigh about 160 or 170 to the pound. 15 (sometimes 12), or a caliber .69 ball and 3 buckshot, were put up in a cartridge.

They are usually made by molding or compression.

Buck'skin. A species of soft leather, usually of yellow or grayish hue, originally (as its name imports) prepared by treating deer-skins in a peculiar way; it is now, however, mostly prepared from sheepskins. There are two processes for dressing skins to give the soft character which is admired in buckskin; one is by oil, and the other by *brains.* The latter more nearly resembles the Indian mode, and both of them require a great deal of manipulation. As to the former, the skins are limed, then worked out on the beam; then they are milled, straits-oil being mostly used, in the proportion of seven to fifteen gallons to 100 skins, according to size. The surplus oil runs through the mill into tubs of water below, whence the oil and water are pumped into a tank in which a certain amount of oil of vitriol is placed; this causes the oil to rise to the top, whence it runs off into barrels, and is known as sod-oil, being used for stuffing and dressing calfskins. The skins are then worked over the beam again, this operation being known as "scudding." The skins are next dried; then they are put into a lye consisting of from fifteen to forty pounds of soda-ash for 100 skins; this takes out the animal oil, which rises to the top and is skimmed off for sod-oil. They are scoured and dried repeatedly, and then undergo the operation of staking; the last operation is the finishing, which is done first on a pumice-wheel and then on an emery-wheel. The skins are then ready to go to the cutting-shop.

By the other plan, the skins are *grained, brained,* and *smoked.* The skin is soaked till soft, the hair and cuticle curried off, beamed, stretched, and broken in drying. It is then soaked in brains dissolved in warm water, which makes the skin thick and spongy. It is carefully stretched and worked, and is tested by gathering into a sack-form and inflating, when pressure will drive off the contained water in a spray. It is now wrung, stretched, rubbed, and hung in a smoke. A slight tanning in willow-bark ooze sometimes follows.

Buck-wag'on. (*Vehicle.*) A rude wagon formed of a single board resting on the axletrees, and forming by its elasticity a spring seat for the driver.

Buck'wheat Hull'er. A form of mill, or an ordinary grinding-mill with a particular *dress* and *set* of the stones, adapted to remove the hull from the grains of buckwheat, preparatory to grinding the farinaceous portion into flour.

Bud'ding-knife. (*Agriculture.*) A knife with a convex blade and flattened handle, used for cutting the scion, making the incision, and inserting buds beneath the bark of fruit-trees. A spear-shaped slip of ivory at the hilt is used for loosening the bark from the wood.

Bud'dle. (*Mining.*) An oblong inclined vat in which stamped ore is exposed to the action of running water, in order that the lighter portions may be washed away while the heavier are retained. Several different descriptions of apparatus are called by this name as generic.

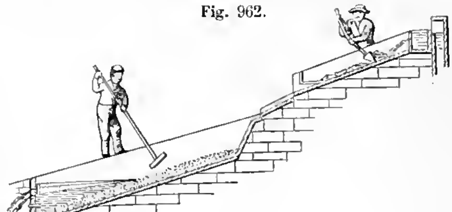
The *trunk-buddle,* or *German chest.* See TRUNK.

The *stirring-buddle,* consisting of a trough and settling-tank.

The *nicking-buddle* or *sleeping-table, buddle-hole* or *sluice-pit.*

Buddles of different construction are known as *flat, round, hand, rotating, concave.* Many of the contrivances for gold-washing, used in California

Fig. 962.



Buddle.

and known by technical names, may be called buddles. The *rockers, long-toms,* and *sluices* act in this manner. The buddle represented is used in Cornwall, England.

The ore is spread over an inclined board, and a divided stream of water directed upon it, so as to gradually carry it down to a lower level, where the inclination is not so great. The quantity of water is regulated by the roughness of the ore, and may be at the maximum as much as would run through a circular aperture $1\frac{1}{2}$ inches in diameter, down to an amount equal to one tenth of that quantity. The richer and heavier ores subside first, and the lighter portions are carried farther on. The contents of the buddle are then separated into three or four qualities, according to their proximity to the head of the buddle.

The various lots are again *buddled,* or *tozed,* or subjected to the action of the *keeve* or *jigging* machine.

Bud'dling. (*Mining.*) Separating the ore from the refuse in an inclined trough or cistern through which water flows. See BUDDLE.

Bude-light. Invented by Mr. Gurney of Bude, Cornwall, England.

It consists of an oil or gas burner, supplied with a jet of oxygen gas, by which the brilliancy of the flame is increased.

In the Argand form of burner the oxygen gas is supplied up the central tube.

Budge-bar'rel. (*Ordnance.*) A small copper-bound barrel having only one head, its mouth being closed by a leathern bag with a cap and draw-string. It is used for supplying the guns of forts and siege-batteries with cartridges from the magazine.

Bud'ge-ro. (*Boat.*) A large pleasure-boat used on the Ganges.

Bud'get. (*Tiling.*) A pocket used by tilers for holding the nails in lathing for tiling.

Buff. A polishing leather.

A slip, lap, or wheel covered with leather and used for polishing. So called, as the kind of leather used was buffalo, was dressed with oil or brains, and had a soft and fuzzy surface. See BUFF-LEATHER.

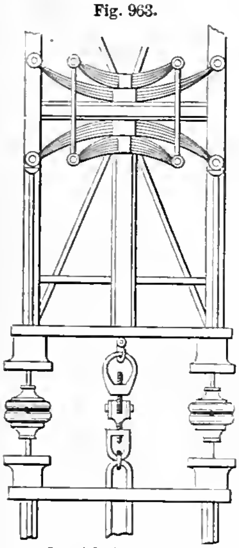
Buf'fa-lo. (*Cotton-manufacture.*) A hamper of buffalo-leather used in a factory to convey bobbins from the *throstle.*

Buf'fer. An elastic device or fender for deadening the shock caused by the impingement of one object against another.

A fender or resilient pad or block, placed on the end of a sill-piece of a car-bed to moderate the concussion of colliding cars. According to the construction and application, it assumes a specific name; and the parts involved are also distinguished with this word as an affix, e. g., —

The *buffer bar* or *beam* is attached to the framework of the car, and carries the *buffer-box*, in which is the *buffer-rod*, on whose end is the *buffer-disk;* the latter receives the impact, which is resisted by the *buffer-spring*, inclosed in the box.

Fig. 963.



English Car-Buffers.

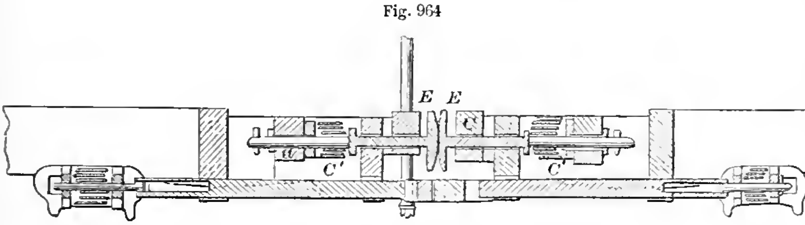
The buffers in use on English railways consist of disks of metal or wood which project from the ends of the carriages, and are commonly covered with cushions of leather. The disks are attached to iron rods placed underneath the frame of the carriage, and as they are pressed inward by the contact of the adjoining carriage, act against the ends of elliptic springs, which lessen the jar resulting from the contact. The aim of the English mode of coupling is to bring the whole train to the condition of an object whose unyielding sections have a cartilaginous articulation, which permits a certain degree of flexure, extension, and compression at the joints.

Another form is a short spiral spring covered with leather and having a disk at the end, placed at the end of each of the main side-timbers of the car-frame.

A third form has a central buffer with a shaft acting upon a spiral spring beneath the carriage-body.

In the example, the buffer-disks *E E* are on rods having shoulders which impinge upon coiled plate-springs *C.* Beneath the car-beds are seen the springs of the car-coupling.

Fig. 964



Car-Buffer.

In a fourth, the shaft acts upon a piston in an air-cylinder, the spring being pneumatic.

There are various modifications.

The *buffers* sometimes take the form of elastic cushions of leather, stuffed with horse-hair; or of disks or blocks of vulcanized rubber.

Buf'fer-spring. That which gives resiliency to the buffer, and enables it to moderate the jar incident to the contact of two cars.

The *buffer and draw spring* is effective both as to colliding contact and also as to the drawing apart in starting or increasing speed.

Buf'fing and Pol'ish-ing Ma-chine'. One having a wheel covered with what is technically known as buff-leather, though not usually made of buffalo-hide. The leather holds the polishing material, crocus, rouge, or what not. Buffing has come to mean polishing, from the derived name of the material which is used in applying the polishing material.

Buff-leather. A strong oil-leather prepared from the hide of the buffalo, elk, or ox. It is so named from the *buffe*, or wild bull, of Poland and Hungary. Formerly it was largely used for armor. It was said to be pistol-shot proof, and capable of turning the edge of a sword. It was tanned soft and white. Its place is now filled by the leather of cow-skins for a common, and of the American buffalo (*bison*) for a superior, article.

It is yet much used in the saber, knapsack, and cartridge-box belts of European armies.

The buffers and buff-wheels of the cutler, lapidary, and polisher were originally covered with the said *buff*-leather, and some are yet.

A thick, tough, felted material of which belts were made was formerly commonly known in the military service as *buff*, probably from its yellow color when not pipe-clayed; and armorers' buff-sticks, etc., are generally covered with pieces from old belts. It was an excellent material for this purpose.

Buff-stick. (*Polishing.*) A strip of wood covered with buff-leather charged with polishing-powder.

Buff-wheel. (*Polishing.*) A wheel of wood or of other material, covered with leather, and used in polishing metals, glass, etc. The surface is plied with material of coarse or fine quality, according to the character and condition of the work, one buff-wheel always having its own grade of polishing-powder, be it *emery, rotten-stone, tripoli, crocus, rouge, putty-powder*, etc.

Bug'ga-low. (*Vessel.*) An East India coasting-vessel with one mast and a lateen sail.

The *buggarah* is an Arab vessel of the Persian Gulf. The *bugis*, a prahu or boat trading between Singapore and the islands of the Indian Archipelago.

The *bujrah* is a flat-bottomed Ganges boat with cabins.

Bug'gy. (*Vehicle.*) A light four-wheeled vehicle, having a single seat. The top, when it has one, is of the *calash* kind. In this case it is commonly known as a *top*-buggy.

Bug'gy-boat. One having a provision for the attachment of wheels, so as to be converted into a land vehicle.

It was invented and used by Sir Samuel Bentham, in Russia, 1781, and was patented by him. He afterwards extended the idea to baggage-wagons. A flexible boat of connected sections was also used by him to convey the Empress Catharine down the Dneiper, and was called by him the "Vermicular." The idea has been lately revived on the Thames, the boat being called the "Connector." Bentham's boat had six sections, drew six inches of water when loaded, and was rowed by 124 oarsmen. No space of more than an inch was to be found between the sections during flexion of the worm-like vessel. The vessel was fitted up with cabins and many conveniences.

Bug′gy-cul′ti-va′tor. (*Agriculture.*) One having wheels and a seat so that the person may ride. See CULTIVATOR.

Bug′gy-plow. One having usually several plows attached to a single frame, and having a seat for the plowman, who rides and drives. See GANG-PLOW.

Bug′gy-top. (*Vehicle.*) The calash top of the single-seated vehicle known as a buggy. In many of these carriages it is now made shifting, so that it may be entirely detached from the frame of the seat and constitute the vehicle an *open* buggy. In other forms the *top rail* only of the seat is shifting.

Bu′gle. 1. (*Music.*) A brass wind-instrument of the trumpet kind.

2. A long, slender glass bead; sometimes arranged in ornamental forms and attached to various articles of ladies' wearing-apparel. *Wampum*, which formerly served as a circulating medium among the North American Indians, was composed of beads of this kind made from the interior parts of clam-shells, by rubbing pieces of the shell into the required shape upon a hard stone, drilling a longitudinal hole, and polishing by friction. Those formed from the bluish-black portions of the shell were twice the value of the white ones.

The ancient Egyptians made many kinds of beads. Ladies are represented stringing them; a purse has been found knitted with small glass bugles.

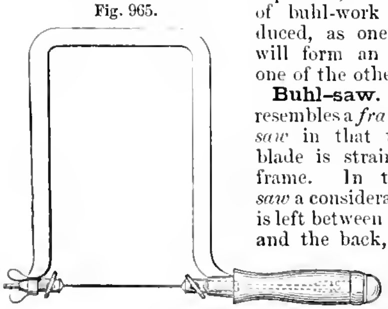
Buhl. The name is derived from André Buhl, an Italian who was celebrated in France, in the reign of Louis XIV., for making artistic work in dark-colored tortoise-shell or wood, inlaid with brass and ornamented with the graver.

The term is now more general, and includes work in contrasted materials, inlaid with the saw.

Reisner preferred wood, and his productions were known as *Reisner-work.*

Veneers or thin plates of the substances are glued to the opposite sides of a sheet of paper; another sheet is pasted on one outside surface, and on this the design is traced. A fine frame-saw called a *buhl-saw* is made to follow the tracing, cutting through both thicknesses. The two layers are then separated, and two pieces of buhl-work are produced, as one of each will form an inlay to one of the other.

Fig. 965.



Buhl-Saw.

Buhl-saw. This saw resembles a *frame* or *bow saw* in that the thin blade is strained in a frame. In the *buhl-saw* a considerable space is left between the blade and the back, in order that the latter may avoid the angle of large works.

Buhr. A coarse, flinty, cavernous stone, whose cellular texture makes it highly suitable for mill-stones.

France, Sardinia, and Germany yield the *buhr-stone*.

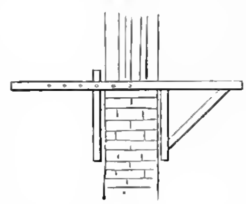
The separate blocks which are hooped together to form a buhr-stone are known as *panes.*

The French buhrs are from a quarry near Paris, where the stratum is about three millstones thick. It is a porous silicious stone of great hardness.

Buhr, Me-tal′lic. A grinding-plate of metal, made as a substitute for the real *buhr*-stone, and used for some coarse work, such as grinding corn for stock.

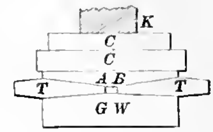
Build′er's Jack. A kind of scaffold which is supported on a window-sill and against the wall, and extends outwardly, to enable a workman to stand outside while repairing or painting.

Fig. 966



Builder's Jack.

Fig 967.



Building-Block.

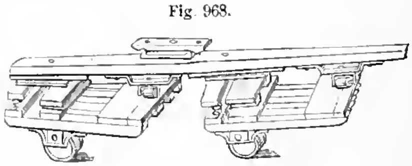
Build′ing-block. (*Shipbuilding.*) One of the temporary structures resting upon the *slip*, and supporting the keel of a ship while building.

They consist of blocks of timber so arranged as to be removable by knocking out the key-pieces or templets.

C C, caps.
A B, angle-block, shod with iron.
T T, wedges called *templets.*
G W, groundway.
K, keel.

Build′ing-mov′er. A heavy truck on rollers or wide track-wheel, used in moving houses. In the example, the building rests on a cross bolster, which

Fig. 968.



Building-Mover

is supported by two trucks with three rollers each. In turning, rollers journaled beneath the bolster traverse ways upon the trucks.

Build′ing-slip. (*Shipwrighting.*) A yard prepared for shipbuilding. See LAUNCH; HYDRAULIC SLIP; SLIP-DOCK.

Built-beam. (*Carpentry.*) A compound beam made up of a number of planks, or thin, deep beams, laid parallel and secured together.

Built-rib. (*Carpentry.*) An arched beam made of parallel plank laid edgewise and bolted together. See ARCHED BEAM; RIB.

Built-up. Said of masts made of pieces and hooped; and of cannon having an inner core and outer reïnforcements.

Buke-mus′lin. (*Fabric.*) A plain, clear kind of muslin, woven for working in the tambour and for ladies' dresses. (SIMMONDS.) Generally written *book*-muslin.

Bulge, Bilge, or Bouge. 1. (*Coopering.*) The swell of a cask, principally in the middle.

2. (*Shipbuilding.*) The flat portion of a ship's bottom. See BILGE.

Bulk'head. (*Shipwrighting.*) A partition in a ship which divides the interior space into compartments. In wooden vessels they are made of timber, and in ships of war are so arranged as to be easily removed in preparing for action, etc. In iron vessels they are formed by plates riveted to the ribs or frames, both on the sides and bottom, each bulkhead making a complete transverse section of the vessel, and the whole being so secured as to prevent water passing from one side to the other. Several of these, being introduced, divide the vessel into water-tight compartments.

The bulkheads affording the greatest protection are those placed a few feet respectively from the stem and stern; the forward one checking the water that would enter through a damaged stem, and the after one averting the danger of any accident that might arise to the stern-post or rudder-braces, or to the tube of the shafts of screw-vessels. The water received into these small compartments would very slightly impede the way of the ship by throwing her out of trim, as the quantity they would contain would be comparatively trifling. The bulkheads more amidships assist in strengthening the vessel, and prevent fire spreading beyond the compartment in which it commenced. In case of a leak, they confine the water to that compartment where it entered.

Water-tight bulkheads have for ages been in use in China, but have only been generally introduced into this country since iron ships have been used; they are now generally employed in iron vessels, and their adoption has become a law and is enforced in England, under the regulations of their Board of Trade; in small vessels they can only be used transversely, but in larger ones they may be applied longitudinally, and are so employed in the "Great Eastern," or were before she was refitted to adapt her for the great work of laying the submarine cables of the world.

The ship "Terror," Commander Back, fitted with bulkheads for Arctic service in 1835, came home with the after section full of water.

Bull-dog. (Fr. *torchis.*) (*Metal-working.*) A refractory material used as a lining for the boshes of puddling or smelting furnaces. It is a decomposed protosilicate of iron.

Bul'len. The awn or chaff from flax or hemp.

Bul'len-nail. An upholsterer's nail, with a round head, a short shank, turned and lacquered.

Bul'let. (From the French *boulet*, diminutive of *boule*, a ball.) A small projectile for fire-arms.

The use of round bullets dates back to the time when gunpowder was first used in ordnance. Bullets are now usually cylindrical, with conical or conoidal points.

In 1418, four thousand bullets were ordered to be made of stone from the quarries of Maidstone, England. These were probably for cannon, as were the iron ones mentioned in Ryder's "Fœdera," 1550.

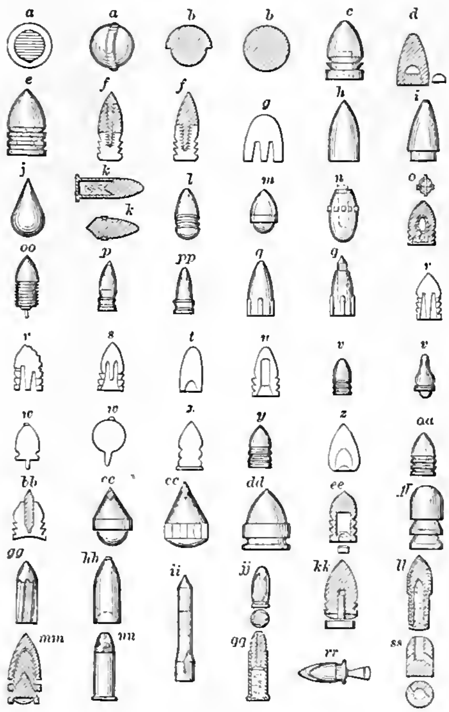
The trajectory of a bullet is the line described by its center on its passage through the air. It would be a parabolic curve in a vacuum, but the resistance of the atmosphere greatly modifies this and reduces the range, so that a 24-pdr. cannon-ball, fired at an angle of 45°, with an initial velocity of 1,400 feet per second, ranges only some 2,100 yards instead of more than 20,000, as it would do if the atmosphere offered no resistance.

The actual velocity of the smooth-bore musket round ball, weighing 412 grains, with a charge of 110 grains powder, at the time of leaving the gun, has been found to be 1,500 feet per second, and that of the elongated ball, cal. .58 of an inch, with 60 grains of powder, 963 feet; but though the latter has so much less velocity at the time of leaving the gun, its range is at least equal and its accuracy far superior.

The greater accuracy of the rifle is due to the fact that the rotary motion given the bullet by the spiral grooves of the gun keeps it always point foremost, and that the bullet is caused to completely fill the bore so that it leaves it in a line with the axis of the piece, which rarely happens in a smooth-bore gun, owing to the difference in diameter between the bullet and the bore.

The rifle was introduced by Koller, a gunsmith

Fig. 969.



Bullets.

of Nuremberg, about the beginning of the 16th century, and the increased accuracy given by this species of arm was soon appreciated; and from the fact of a troop of horse known as Carabins having been armed with them, the weapon itself was subsequently called carbine.

The round ball, however, still held its place until very recently, both for rifled and smooth-bore guns; and it was not until the wars of the French in Algeria, subsequent to 1830, that experiments on an extended scale were made as to the practicability of using that form of projectile, the pointed and elongated, which both mathematics and common-sense showed to be best adapted to both accuracy and long range.

Among the first of the improved balls was the Brunswick (*a*, Fig. 969), which had a circumferential belt, and was adapted for a two-grooved rifle. *b b* is the Delvigne, adapted for a sub-caliber powder-chamber, and resting by an annular shoulder upon a wooden sabot. It had a patch of greased serge. Minie and Thouvenin introduced an elongated bullet with a cylindrical grooved body and a conical point. This had a greased paper patch, and was expanded to fill the grooves by being driven down upon a *tige* in the breech of the gun. This was adopted in the French service in 1846. Delvigne subsequently patented an elongated bullet with a recessed base which he called the *cylindro-ogival*.

Minie, in 1847, produced the well-known bullet *c*, in which the *tige* was dispensed with, and the bullet expanded by the explosive force of the powder in the cup, which was inserted into a frusto-conical cavity in the base of the bullet. The English substituted a conoidal wooden plug in their Enfield-rifle bullet *d*.

In 1856, after a series of experiments by the Ordnance Department, an elongated bullet *e*, with a cavity, was adopted for the United States army. The diameter is .577 of an inch, that of the arm for which it is intended being .58 of an inch. Two varieties were made, both being precisely similar on the exterior, but differing in the size of the cavity; that for the rifle-musket weighing 500 grains, and the other for the pistol-carbine but 450 grains.

f f is the bullet of Thirouse, a French artillery officer. It is composed of lead backed by a sabot of wood with three circular grooves near its base. The Nesler ball *g* was intended for a smooth-bore.

Of the other bullets in Fig. 969, some are celebrated on account of the ingenuity or success of their inventors, others as having been adopted by different governments.

h is the American conoidal pointed bullet.

i, the Colt, with a rabbet for the cartridge capsule.

j, the American "picket," with a hemispherical base.

k k, Haycock's Canadian bullet, with a conoidal point and a conical base.

l, Mangeot's bullet with a conoidal point, hemispherical base, and two circular grooves.

m, the Prussian needle-gun bullet.

n, Norton elongated percussion rifle-shell, fitted with wooden plug (1830).

o, Gardiner's explosive shell-bullet, cast around a thin shell of copper attached to a mandrel, which is afterwards withdrawn, leaving a fuse-hole in the rear through which the charge is exploded in about 1¼ seconds.

oo is a Spanish bullet containing a charge of powder and a fulminate.

p is the Swiss federal bullet.

p p, the Swiss Wurstemberger bullet.

q and *q* are views of the Jacob's bullet and shell.

r and *r* are views of the Peter's ball, having an interior tige; one view shows it distended and battered.

s is the Belgian bullet.

t, Pritchell's bullet.

u, Mangeot's bullet.

v v, Austrian bullets.

w w, Deane and Adams's bullets, with tails.

x, English bullet, with wad.

y, Sardinian bullet.

z, Beckwith's bullet.

a a, steel-pointed bullet.

b b, the Charrin bullet, with zinc or steel point.

c c, *c c*, Tamissier's steel-pointed bullet; one view showing it intact, and the other after compression in the grooves of the rifle.

d d, the Saxon bullet.

e e, the Baden modification of the Minie, with tinned iron cup.

f f, Wilkinson's bullet.

g g, Whitworth's hexagonal bullet.

h h, Lancaster's bullet.

i i, Mefford's sub-caliber bullet, with spiral grooves on the shoulder to impart rotation.

j j, McMurtry's bullet, with spiral grooves.

k k, Williams's bullet, with a headed tige to expand a rounding disk at the base.

l l, Dibble's bullet, with a recess for the powder.

m m, Shaler's triple bullet, the pieces of which are intended to diverge after leaving the muzzle.

n n, Maduell's bullet, which is built up of interlocking portions, which part as they leave the capsule and muzzle.

q q, Shocks's perforated bullet, with a sabot in the rear.

r r, Hope's bullet, with a bent tail to direct it in a curved path.

s s, Matteson's bullet, with spiral openings through it.

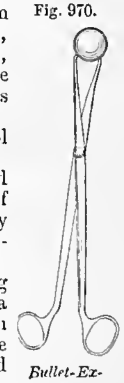
The following table shows the number of spherical leaden balls in a pound, from 1$\frac{5}{10}$ to .237 of an inch diameter: —

Diam.	No.	Diam.	No.	Diam.	No.	Diam.	No.	Diam.	No.
Inch.		Inch.		Inch.		Inch.		Inch.	
1 67	1	.71	13	.488	40	.329	130	.265	250
1.326	2	.693	14	469	45	.321	140	.262	260
1.157	3	.677	15	.453	50	.314	150	.259	270
1 051	4	.662	16	.426	60	.307	160	.256	280
.977	5	.65	17	.405	70	.301	170	.252	290
.919	6	.637	18	.395	75	.295	180	.249	300
.873	7	.625	19	.388	80	.29	190	.247	310
.835	8	.615	20	.375	88	.285	200	.244	320
.802	9	.57	25	.372	90	.281	210	.242	330
.775	10	.537	30	.359	100	.276	220	.239	340
.75	11	.51	35	.348	110	.272	230	.237	350
.73	12	.505	36	.338	120	.268	240		

Bul'let-com'pass-es. A pair of scribing compasses with a bullet on the end of one leg to set in a hole. *Cone-compasses*, *Club-compasses*.

Bul'let-ex-tract'or. A pair of pinchers with projecting claws, adapted to imbed themselves in a bullet so as to draw it from its bed and extract it. When closed, these form a smooth, blunt surface, like a probe, and are opened against the bullet so as to spread apart the vessels which might oppose the retraction.

Fig. 970.



Bullet-Extractor.

Bul'let-hook. A hook-ended tool for extracting bullets.

An iron bullet-hook was disinterred at Pompeii in 1819 by Dr. Savenko, of St. Petersburg. It was in company with a number of other surgical instruments. See PROBE.

Bul'let-la'dle. One for melting lead to run bullets. It is usually a hemispherical ladle with a spout, but in one case the ladle has a hole in the bottom guarded by a spring plug and operated by a trigger on the handle; in another case a part of the ladle is covered, and the lead thus flows out at a guarded opening which keeps back the dross of oxide.

Bul'let-mak'ing Ma-chine. Leaden bullets, as well for the military service as for other purposes, were formerly all made by casting.

The most common form of bullet-mold, where large numbers of bullets were required, was precisely like the common bullet-mold, but casting four, six, or more bullets. The gates were afterward cut off and the bullet trimmed by hand. The whole process was slow, and required a comparatively large number of hands.

To increase the rapidity of fabrication, revolving bullet-molds were tried, consisting of a cylindrical ring, to which revolution was imparted by a hand-crank and gearing, the molten lead being fed to the mold during its revolution; the gates were cut by a knife attached to the mold at the same operation; when full, the mold was opened and the bullets discharged, after which the mold was clamped shut again and the operation recommenced. These contrivances were ingenious, but were very liable to get out of order.

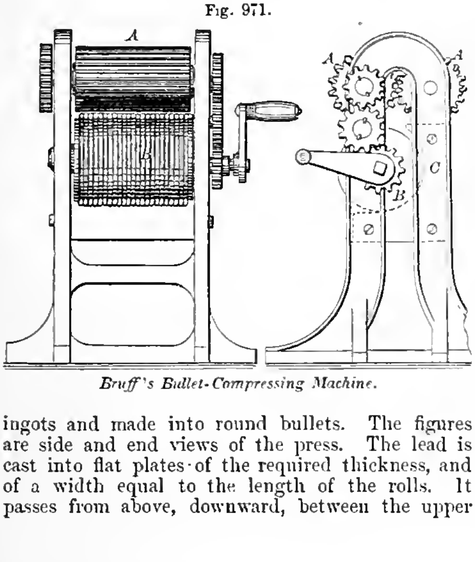
In 1857, De Zeng invented a mold for elongated bullets, constructed very similarly to the ordinary bullet-mold on a large scale, but which was mounted on a stand and worked by means of a treadle, through which, aided by the hands of the operator on the handles, the mold was opened and closed, and the gates cut off. This was an ingenious and efficient apparatus, and, with the aid of a boy to pour the lead, could be worked with great rapidity, seemingly limited only by the time required for the cooling of the metal at each cast.

Pressed leaden bullets are undoubtedly superior to cast ones, and those for the ordinary arms in the military service are made in the former way. The lead is generally procured in the form of "bullet wire," coiled on reels. This is cut in lengths of 25 inches, and fed to the machine by a boy. Elongated bullets are formed by a three-part die, which opens and closes with great rapidity, delivering the bullets at the rate of about 3,000 per hour; these have a slight burr or feather at the points where the dies come together, which is afterwards trimmed off by hand.

Molds and rolls are provided with each machine, so that the bars may be cast from the pig, and rolled to give them density; but, as observed above, the lead is generally procured in the form of wire. It is estimated that a man can cast 1,500 bars, or trim and roll 2,000 bars, in a day of ten hours.

BRUFF's machine, 1813, has a furnace and a press, in which respectively the lead is cast into

Fig. 971.



Bruff's Bullet-Compressing Machine.

ingots and made into round bullets. The figures are side and end views of the press. The lead is cast into flat plates of the required thickness, and of a width equal to the length of the rolls. It passes from above, downward, between the upper pair of rolls *A*, which are grooved longitudinally; by them it is pressed into round rods, — or, more correctly, long cylindrical pieces, — one half of each of which is formed by the groove in the face of one roll, while the other half is formed by the corresponding groove in the opposite roll, the two working in apposition and moving at an equal rate. Each bar, as it falls from the upper rolls, alights upon the lower roll *B*, which is grooved circumferentially, and carries the round bar against the curved steel plate *C*, whose face is grooved in correspondence to the grooves of the wheel *B*. The bar is nipped between the surfaces, and is cut into sections by the adjacent edges of the roll and plate, and as the pieces roll down in the grooves of the plate and are pressed on the opposite sides in the grooves of the roll, they gradually assume a perfectly spherical form and are discharged.

The elongated shot or bullets now used for rifles are made at Woolwich in the following way: The machine for this purpose consists of four sets of duplicate punches and dies, independently worked in pairs by two eccentrics, driven by gearing from two separate driving-shafts. The lead, coiled round four reels, is fed from them through a shearing-lever into the grippers, where it is clutched; a piece is cut to a suitable length by an upward movement of the shearing-lever; the grippers then open, the piece cut off falls down, and is clutched by another piece of apparatus. At this moment a punch advances, and presses the lead into the die, thus forming a bullet. A small plate comes up immediately in front of the die, and the bullet is pushed through it by a small pin, worked by a lever and cam; by this operation the ragged edge is removed which had been left on the bullet by the die. The machinery, when driven at the rate of thirty revolutions per minute, will make 120 bullets in that time, or 72,000 in a day of ten hours.

Bul'let-mold. An implement opening like a pair of pinchers, having jaws which shut closely together, and a spherical or other shaped cavity made by a cherry-reamer, with an ingate by which the melted lead is poured in.

Bul'let-probe. A sound for exploring tissue to find the *situs* of a bullet. It is usually a soft steel wire with a bulbous extremity. Nelaton used a sound with a file-like extremity, which might receive traces of the bullet in cases where there is doubt of the character of the body with which it is brought in collision. He afterwards used a *sonde*, with a termination of an olive-shaped body of white unvarnished porcelain, which would receive a black mark by contact with the bullet.

Bul'let-screw. One at the end of a ramrod to penetrate a bullet and enable the latter to be withdrawn from the piece. See BALL-SCREW.

Bul'let-shell. An explosive bullet for small-arms. Jacobs's bullet-shells, used with the rifle of General Jacobs of the East India service, have an inclosed copper tube containing the bursting-charge, which may be fulminate or common powder, and is exploded by a percussion-cap or globule on striking.

In experiments made with them at Enfield in 1857, caissons were blown up at distances of 2,000 and 2,400 yards; and brick-walls much damaged at those distances by their explosion. See BULLET.

Bul'ling. (*Blasting.*) Parting a piece of loosened rock from its bed by means of exploding gunpowder poured into the fissures.

Bul'lion. 1. A word whose original meaning indicated a rounded stud or ornament, and came to mean a metallic clasp, boss, hook, button, or buckle.

The meaning has diverged in two directions.

It now means (*a*) a mass of gold or silver in bars or in mass, uncoined; and, by association, a showy metallic ornament or metal-covered fringe; if genuine, of gold or silver, but sometimes a mere colorable imitation in baser metal.

b. A form of heavy twisted fringe, whose cords (L. *bulla*, an object swelling up and becoming round) are prominent; as, in degree, the strands of a cable.

Bullion-fringe for epaulets is made of silk covered with fine gold or silver wire.

2. (*Glass-making.*) The extreme end of the glass bulb at the end of the blowing-tube. The bulb having assumed a conical form is rested on a horizontal bar called the *bullion-bar*, to assist in bringing it to the spherical form.

Bull-nose Ring. A hook whose knobs enter the nostrils and clamp the dividing cartilage or septum of the nose. It is used to lead vicious or obstinate bulls, and occasionally to fasten or hitch them.

A passage in Ezekiel shows that lions and camels were similarly led about, and that prisoners and captives were treated in the same way. Manasseh, the vicious and unfortunate king of Judah, was thus led by the nose, and carried away captive, 677 B. C., by the captain of the host of the king of Assyria. Repenting in exile, he was restored, and died in peace in Jerusalem.

A bas-relief, discovered by Layard at Khorsabad, shows that the practice was considered worthy of illustration by permanent record; and it certainly was far more humane than the Egyptian modes of tying prisoners in the times of the Rameses, and the practices in vogue among the savages of Turkestan at this day, and which we hope are now in course of abatement by Russia.

Bull's-eye. 1. (*Nautical.*) *a*. A small pulley of hard wood, having a groove round the outside and a hole in the middle, answering the purpose of a thimble.

b. A bulb or thick disk of glass let into a ship's side or deck.

c. One of the perforated balls on the *jaw-rope* of a *gaff*.

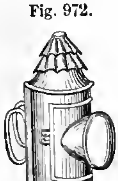
2. The center of a target.

3. The lens of a dark-lantern.

4. (*Glass.*) The central boss which is attached to the bunting-iron or pontil, in the operation of making crown-glass.

5. (*Microscope.*) A plano-convex lens, used as an illuminator to concentrate rays upon an opaque microscopic object.

Fig. 972.



Dark-Lantern

6. A small lantern with a lens in one side of it, to concentrate the light in any given direction. A *policeman's*, *watchman's*, or *dark* lantern. It has a slide by which the emission of light is prevented, and is unfortunately almost as handy for burglars as policemen. A *dark-lantern*.

Bull's-eye Crin'gle. (*Nautical.*) A wooden ring or thimble used as a cringle in the leech of a sail.

Bull's-nose. (*Carpentry.*) A term sometimes applied to the angle formed by the junction of two plane surfaces.

Bul'wark. 1. A rampart, wall, or parapet around an inclosure, such as a fortification or battery.

The *boulevards* of Paris and other cities are on the site of the ramparts of the former fortifications.

2. (*Nautical.*) The sides of a ship above the upper deck.

Bum'boat. (*Nautical.*) A boat used to carry provisions to vessels. So named from its clumsy form.

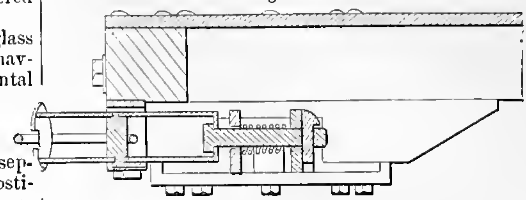
Bum'kin; Boom'kin. (*Nautical.*) *a*. A boom on each side of the bow, to haul the fore-tack to.

b. On the quarter for the standing part of the main-brace.

c. Over the stern, to extend the mizzen.

Bump'er. A projecting head at the end of a railway-car, to receive or deliver the contact when cars

Fig. 973.

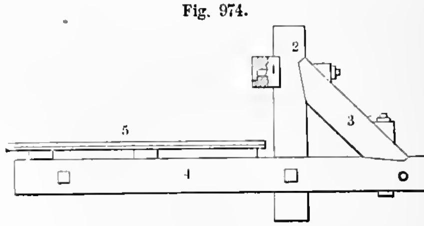


Car-Bumper.

come together, and, by transferring the force to a spring, moderate the jar incident to the collision. In the illustration the spring is of a spiral form. See also BUFFER.

Bump'ing-post. (*Railway Engineering.*) A timber or set of timbers at the termination of a railroad track, to limit the motion of the train in that direction. In the example, the three members, —

Fig. 974.



Bumping-Post

sills 4, posts 2, and braces 1 3, — are bolted together, and a part of the strain transferred from the posts and thrown upon the sill beneath the track.

Bunch. 1. (*Mining.*) The expanded portion of a *pipe-vein*; that is, one which, instead of preserving a uniform size, has contractions and expansions. A body of ore not continuous like a *course*. Also called a *squat*.

2. (*Flax-manufacture.*) Three bundles, or 180,000 yards, of linen yarn.

Each *bundle* has 60,000 yards, and is made up of 20 hanks, each having 10 *leas*, and each *lea* being 300 yards in length. See BUNDLE.

Bun'der-boat. The surf-boat of the Malabar coast of India.

Bun'dle. (*Flax-manufacture.*) Twenty hanks, or 60,000 yards, of linen yarn make a *bundle*.

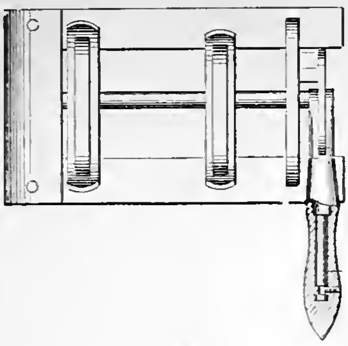
Table.

120 *yarns* of $2\frac{1}{2}$ yards	= 300 yards	= 1 *lea*.
10 *leas*	3,000 yards	= 1 *hank*.
20 *hanks*	60,000 yards	= 1 *bundle*.
3 *bundles*	180,000 yards	= 1 *bunch*.

Bun'dle-pil'lar. (*Architecture.*) A column or pier with others of small dimensions attached to it.

Bun'dling-ma-chine'. One for grasping a number of articles into a bundle ready for tying. Machines of this character are used for fire-wood, asparagus, and many other things sold in tied bundles. The handle is adjusted in position to expand the bands or straps for receiving the article to

Fig. 975.



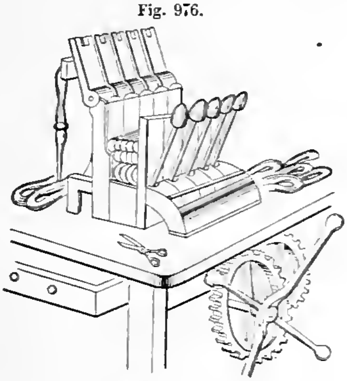
Bundling-Machine.

be bound, when it is drawn down, and by a slight turn of the hand-piece the machine will be locked and the bundle held securely until tied up.

Bun'dling-press. A press in which hanks of yarn are pressed into cubical packages for transportation, storage, or sale.

The press has an iron frame beneath the wooden table, on the respective ends of which the yarn and the tying twine are placed. The hanks of yarn are

Fig. 976.



Bundling-Press.

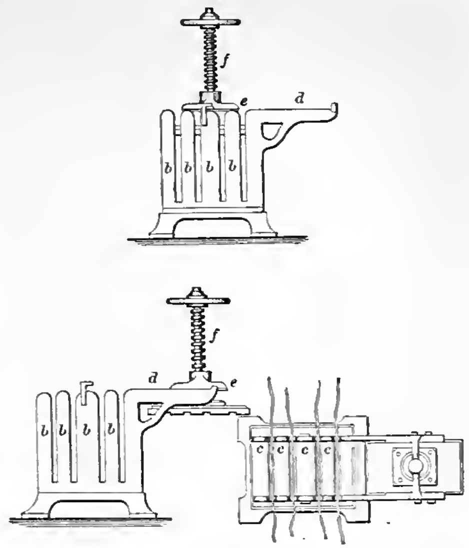
placed between the standards of the press-box, the sides of which are slotted, to allow the strings to be laid in position before the yarn is filled in. The top is then shut down and secured by the key-rods, which enter the notches in the top bars.

The iron cross is then turned, operating a pinion beneath the table; the pinion engages with and turns a large cog-wheel, to one of whose arms a pitman is connected. The pitman raises the follower, which forms the bottom of the press-box, and squeezes the bundle of hanks against the top pieces which form the cover. The strings are then brought around and tied, the slits in the sides and top of the box permitting them to come against the cotton.

After tying, the pressure is slackened, the key-rods withdrawn, the cover thrown back, and the tied bundle withdrawn.

The invention shown in Fig. 977 is primarily designed for bundling yarn, but is adapted for compressing other like materials. It consists of a frame having uprights *b b* at each side, carrying transverse bars *c c* at top. For use, the yarn to be bundled is placed on the bars *c c*, the platen *e* having been previously run out on the extension *d*;

Fig. 977.



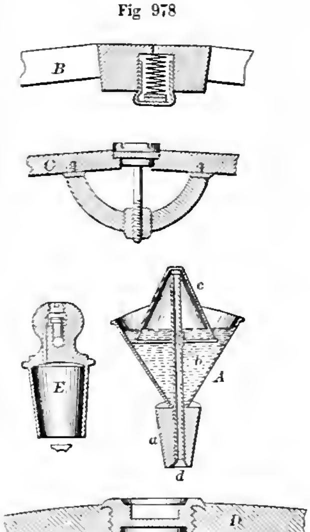
Bundling-Press.

cords are passed around the bundle, and the platen is run in on its guides and forced down by means of the screw *f*, compressing the wool into a small space; the cords are then tied, the platen run out again, and the bundle removed.

Bung. 1. (*Coopering.*) A stopper for the large opening in the bulge of a cask called the *bung*-hole.

The common bung is merely a thick circular piece of wood or cork, over which a square piece of tin is usually nailed. Improved devices relate to means for admitting air to allow the contained liquid to be drawn, or for permitting gases generated inside to escape before attaining a dangerous degree of pressure.

Fig 978



Bungs.

Fig. 978 (*A*) is designed to allow the carbonic acid generated during the process of fermentation to depart without allowing access of external air, whose oxygen aggravates the process.

The carbonic acid passes up tube *d* in the bung *a*, and escapes into the air around the lower edges of the cone *c*, which is submerged in the reservoir *b*, the latter being filled with water, or preferably with the must, wine, or beer with which the cask is filled.

It is a substitute for a bent tube, inserted into the bung, and its other end inverted into a tumbler of liquid which stands on the top of the cask.

B is a bung with a spring plug.

C has an inner bridge into which the stem of the bung screws.

D is a screw-bung.

E is a bung with a vent and a screw vent-plug.

2. (*Pottery.*) A pile of *seggars* forming a cylindrical column in a kiln.

Bung-bor'er. (*Coopering.*) A conical auger for reaming out a bung-hole.

Bung-cut'ter. A machine for cutting bungs.

There are four forms: —

1. The annular borer. (See AUGER.) This has a pointed cutter on a stem, like a center-bit without the routing-cutter.

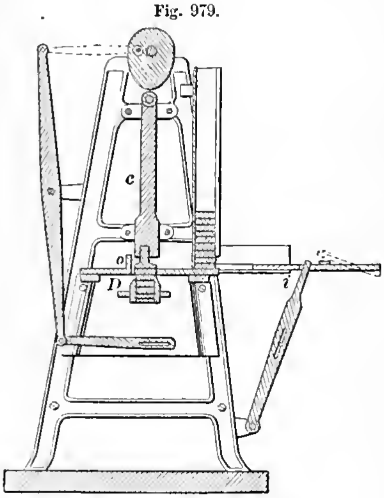
2. A lathe which turns the circular bung.

3. A cylindrical saw which advances against the blank (or conversely) and cuts out a circular disk.

4. A descending tubular knife which cuts the disk out of the stuff, or cuts a square blank into a circular shape.

Of the latter class is Fig. 979, in which the square blocks are placed in a vertical pile in the hopper, and fed automatically one by one to the plunger, by which they are forced through the circular cavity of the cutter and formed into cylindrical blanks. *i* is the feeding slide-bar which pushes the lowest blank of the pile beneath the plunger *c*, which forces it down upon the circular cutter *D*.

Fig. 979.



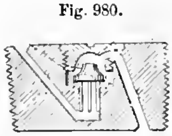
Bung-Cutter.

Bun'go. (*Boat.*) A kind of canoe used in the Southern States and in South America.

Bung-start'er. (*Coopering.*) A *flogger.* A bat to start the bung of a cask by beating on the bulge alongside of the bung.

Bung-vent. A passage for admitting air through the bung of a cask, to allow a free flow of liquid from the tap. In the example, the cavity in the bung communicates with the atmosphere and with the interior of the barrel by separate passages. The valve in the cavity rises freely to admit air, but resists the passage of gases from the barrel. See also BUNG.

Fig. 980.



Bung-Vent.

Bunk'er. (*Nautical.*) A coal-space below decks on steamers.

Bun'sen-bat'ter-y. Invented by Bunsen, Professor of Chemistry at Breslau. Also called the *Electropoion Battery* and the *Carbon Battery.* A modification of the Grove battery, carbon or gas-coke replacing the platinum, and a solution of bichromate of potash replacing the nitric acid of the Grove battery.

In this form of battery, the carbon or coke is sometimes formed into a cup, replacing both the platinum and the porous cup.

There are several modifications of the Bunsen battery, mainly mechanical, looking to a more compact arrangement of the elements, economizing space, etc.

There are also several formulas for the bichromate solution: —

Bunsen: 5 pounds bichromate of potash dissolved in 2 gallons boiling water.

Prevost (September 27, 1870): water, 800: bichromate potash, 50; sulphuric acid, 50; chromic acid, 2.

V. Barjou: bichromate of potash, quicklime, sulphuric acid.

Bastet (September 26, 1871): bichromate of potash, water, nitrates of either soda or potassa, and sulphuric acid.

Bunt. (*Nautical.*) The middle perpendicular portion of a sail.

Bunt'ing. (*Fabric.*) A thin woolen stuff of which flags are made.

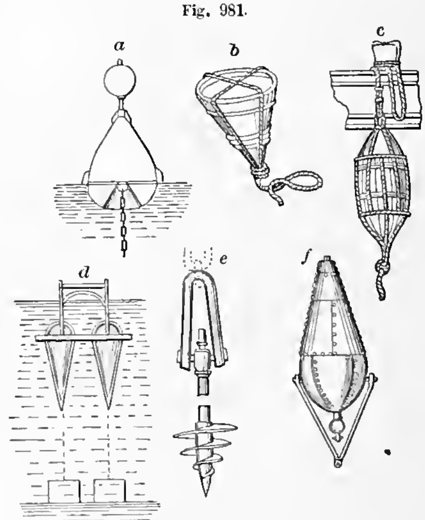
Bunt'ing-i'ron. (*Glass.*) The glass-blower's pipe.

Bunt'line. (*Nautical.*) One of the ropes attached to the foot-rope of a sail, which passes in front of the canvas, and is one of the means of taking it in, turning it up forward so as to spill the wind and avoid bellying.

Bunt'line-cloth. (*Nautical.*) The lining sewed up a sail under the buntline, to prevent the rope from chafing the sail.

Buoy. A floating body anchored or fastened in the vicinity, and employed to point out the position of anything under water, as a ship's anchor, reef, shoal, or danger of any kind.

Fig. 981.



Buoys.

Buoys, in general, are divided into three kinds: the *nun-buoy* (*c*), which is in the form of a parabolic spindle, generally truncated at one end, and when intended as a mark by which to point out a shoal, arranged to carry a mast or frame of cage-work, and loaded so as to float in a vertical position. Smaller buoys of this kind are used as anchor-buoys.

The *can-buoy* (*b*) is conical, frusto-conical, or conoidal in shape, and floats upon its side when moored.

The *cask-buoy* is a short frustum of a spindle, truncated at each end; it is sometimes cylindrical or nearly so. It is chiefly used for carrying the warps of vessels laying at moorings. A good tight common cask may be used for the same purpose, and is far less expensive.

Life or *safety buoys* are intended to save the life of a person falling overboard. They are suspended below a ship's taffrail, and are so arranged that they can be let go at a moment's notice; the same pull which casts the buoy loose lighting a port-fire, to indicate the position of the buoy to the person overboard as well as to the crew of the boat sent to pick him up, thus serving as a point of resort for both. Such is the life-buoy of Lieutenant Cook. A fuse, composed of a proper mixture of phosphide of calcium, is attached to the buoy. In case of a man overboard, the life-preserver is thrown into the water; the moment the fuse becomes wet, it begins to give off a gas which takes fire in the air; and the wetter it becomes the more gas and the brighter the light produced. The light can be made to last an hour. See LIFE-BUOY.

Spar-buoys are also frequently employed to point out channels in rivers and less exposed situations; these are nothing more than masts or spars of proper length, painted of any desired color, and anchored.

Buoys are made either of wood or sheet-iron; gutta-percha stretched on wooden or metallic frames has also been proposed.

When employed to point out shoals or dangers, they are painted of some distinctly visible color, and where more than one is anchored in the same vicinity, their colors are varied so that they may be readily distinguished from each other; for example, the buoys on one side of a channel may be black and those on the other red, so that the navigator can tell at once, by the color, on which side they are to be passed. Herbert's buoy (*a*) is intended to be anchored by having the mooring-chain attached near its center of gravity, so as to reduce the tendency to pitch and roll in rough water and impart greater stability to the buoy; the shape of the buoy and the conical hollow in its base also conduce to these objects.

An improved buoy (*f*), designed to have similar advantages, was patented by W. M. Ellis, Oct. 7, 1856. It is moored by attaching the cables in the line of the calculated center of tidal pressure; and the forked or Y-link or shackle is connected to the buoy by means of a trunnion-bolt passing through a metallic tube or pipe set and secured within the buoy. The figure *f* will show the method of effecting these objects.

Submerged buoys have been suggested, anchored by a weight heavier than the floating power of the buoy. As the weight ceases to exert a sinking force when it reaches the bottom, the capacity of the buoy to sustain a load is the same as if it floated at the surface, and an upright or spindle on its upper part presents but a small surface to the action of waves. Two or more such buoys sunk to the dead-water point may be so arranged as to support a superstructure above the level of the sea, as in *d*.

Buoys in certain situations may be moored by screw-piles (*e*), which are readily driven by rotation into the sand or mud, and energetically oppose retraction.

Other designations are:—

Anchor buoy, one attached by a rope to an anchor to show the position of the latter.

Cable buoy, an empty cask to keep a hempen cable above the bottom in rocky anchorage.

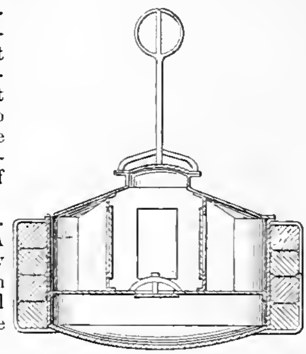
Leading buoy, in the form of a millstone.

Sounding buoy, used in sounding an anchorage-ground.

The *slings* of a buoy are the part of the buoy-rope bent to or around the buoy.

Buoy-rope. (*Nautical.*) The rope which fastens a buoy to an anchor.

Fig 982.



Buoy-Safe.

Buoy-safe. A metallic body divided into compartments, by which it is braced, and having water-tight doors opening to the inside. The buoy has an encircling armor of cork.

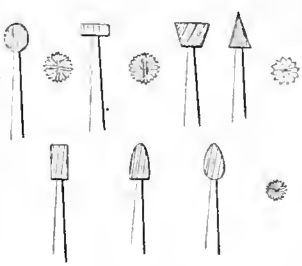
Bur; Burr. 1. (*Machinery.*) A small circular saw or toothed drum used on a mandrel placed between the centers of a lathe.

2. (*Metal-working.*) A roughness left on metal by a cutting-tool, such as a graver or turning-chisel. The bur of a graver is removed by a scraper; that of a lathe-tool by a burnisher or in the polishing process. A bur is purposely made on a currier's knife and a comb-maker's file, and in each case constitutes the cutting edge.

3. (*Knitting-machine.*) A wheel with thin plates or projections inclined to the axis of the bur, and used to depress the thread between the needles and below the *beards;* it is then called a *sinker.* It becomes a *knocker-off* when it raises the loops over the top of the needle. See SINKER.

4. A fluted reaming-tool.

Fig. 983.



Dentist's Burs

5. (*Dentistry.*) A dentist's instrument of the nature of a drill, but having a serrated or file-cut head, larger than the shank. The instruments are made of many sizes, and the heads are spherical, bulbous, cylindrical, frustal, disk-shaped, or conical. In the example are shown the *round, wheel, inverted cone, cone, cylinder, cylindroid, conoid* burs.

6. A triangular chisel.

7. A planchet driven out of a sheet of metal by a punch.

8. A washer placed on the small end of a rivet before the end is swaged down.

9. The *jet, sprue,* or neck on a cast bullet.

Bur-chis'el. A triangular chisel, used to clear the corners of mortises.

Bur-cut'ter. (*Metal-working.*) A nippers for cutting away the flange from a leaden bullet or ball. A *bur-nipper.*

Bur′den. 1. (*Nautical.*) The tonnage or carrying capacity (by weight) of a vessel.

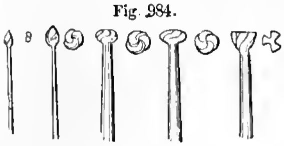
2. (*Metallurgy.*) The charge of a furnace.

3. (*Mining.*) The tops or heads of stream work, which lie over the *stream* of tin.

Bur-dett′. (*Fabric.*) A cotton stuff.

Bur-drill. A drill with an enlarged head used by operative dentists.

Fig. 984.



Bur-Drills.

The set consists of five varieties: The pulp-canal reamer, small and larger; the round bur-drill; the excavator; the undercutting bur-drill. See also BUR.

Bu-rette′. A small, graduated glass tube used in pharmacy or in the laboratory for measuring or transferring small quantities of liquid. It sometimes has a stop-cock, and the discharge through its small orifice is sometimes checked by the finger placed on the opening above, as in the *velinche* or *pipette.*

As invented by Gay Lussac, for dividing a fluid into minute portions, it consists of a large tube, graduated to $\frac{1}{100}$ and $\frac{1}{1000}$, and a smaller parallel connected tube.

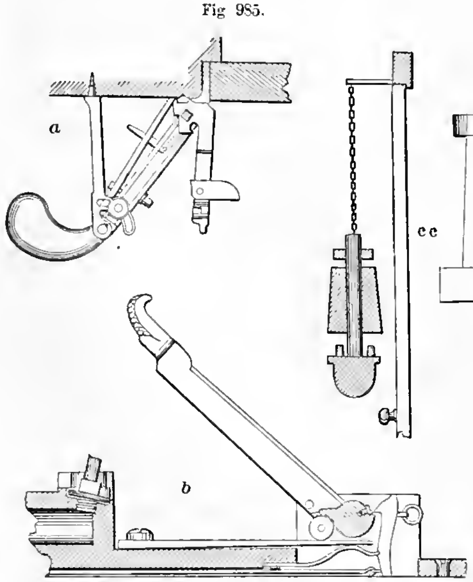
Bur-gage. (*Metal-working.*) A plate perforated with holes of graduated sizes, whose numbers determine the trade sizes of drills and burs.

Bur-gee′. (*Nautical.*) A flag ending in two points. See FLAG.

Bur′geoise. (*Printing.*) A size of type. See BOURGEOISE.

Burg′lar-a-larm′. A device to be attached to a door or a window, to make an alarm when it is opened from without. Some alarms are portable, to be used by travelers in securing their doors against intrusion. As their name indicates, they are intended to make a noise when started, and they consist of bells, pistols, or torpedoes, sometimes associated with devices for lighting a lamp, and in one case (POWELL, July 23, 1861) having an arrangement for upsetting the bed, and thereby calling the attention of the sleeper to the disturbance. The contrivance instanced by the Marquis of Worcester, with alarm, fire, tinder, and pistol, is described in his "Century of Inventions," and is cited *ante*, page 56.

Fig 985.



Burglar-Alarms.

One device has a hinged plate on the threshold of the door, and partially concealed by the carpet. The foot of a person entering the room depresses the plate, and by means of a lever and rod actuates a bell, whose ringing gives notice of the presence of the intruder.

Another: an ordinary clock-alarm is placed within a case attached to the door, and is sprung by the opening of the door.

The illustration shows three forms: a pistol *a* fastened to the door-jamb by its pivoted post, whose tang screws into the jamb. Its muzzle is presented towards the crack of the door, and its trigger is tripped when the door opens, with consequences to the chambermaid or too impulsive friends.

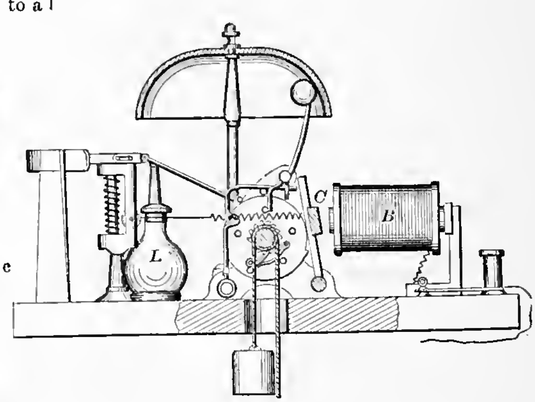
b is placed anywhere in the room, and is tripped by a cord leading to a door or window whose surreptitious opening is to be announced.

c is a torpedo suspended by a pin from the door, and dropped when the latter opens.

Fig. 986 shows one of the numerous forms of the application of the electric circuit and apparatus to guard the windows and doors of a house.

Copper wires running through the house are connected with a battery, and have circuit connections attached to the doors and windows, so that when a door or window is opened the armature is released from the magnets, and causes a bell to strike, and lights a fluid lamp or candle.

Fig. 986



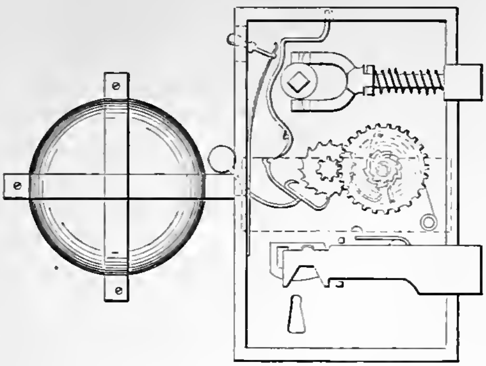
Electro-Magnetic Burglar-Alarm.

The circuit being completed by the motion of the door or window, the magnet *B* attracts the armature *C*, and sets free the detent, so that the weight runs the alarm-hammer, while the match-puller is reciprocated and lights the lamp *L*.

Burg′lar-a-larm′ Lock. A lock with an alarm apparatus attached so that, when properly set, the same will be put in operation and an alarm sounded, in case the bolt of the lock is improperly moved.

When the latch is drawn in, the escapement is set in motion, being driven by the cog gearing and spring, each pulsation of the escapement-lever being a blow of the hammer upon the bell.

Fig. 987



Burglar-Alarm Lock.

Bur'i-al-case. A mummy-shaped form of coffin, made of various materials, wood, metal, earthenware, concrete, asphaltum compounds, papier-maché. Its furnishing and arrangement involve improvements in the lids, glass over the face, means of fastening, hermetical sealing, and the complete isolation of the body from air by enveloping the corpse in a resinous or other air-excluding compound.

Bu'rin. 1. (*Engraving.*) The cutting-tool of an engraver on metal. A graver.

2. (*Masonry.*) A triangular square-shaped steel tool whetted off obliquely at the end, so as to exhibit a diamond. It is shaped like a graver, and is used by the marble-worker.

Bur'lap. (*Fabric.*) A coarse, heavy goods for wrapping, made of jute, flax, manilla, or hemp.

Burl'ing. (*Woolen-manufacture.*) A process in which woolen cloth is examined for rents, flaws, knots, defective yarns, etc., a deficiency being made good with a needle, and offensive matters removed. This is done after *scouring* and before *fulling*.

Burl has the same old English definition as *Bur*, and the name of the process is probably derived from the plan of picking out the *burs* from the cloth.

Burl'ing-i'ron. (*Woolen-manufacture.*) A sort of pinchers or nippers, used in *burling* cloth.

Burl'ing-ma-chine'. One for removing knots and foreign matters projecting from the surface of woolen cloth before fulling.

Burn'er. That part of a lighting apparatus at which combustion takes place. See GAS-BURNER; LAMP-BURNER.

Also applied to the corresponding portions of *gas-heaters* and *gas-stoves* (which see). See also VAPOR-BURNER; PETROLEUM STOVE.

Bur'nett-iz'ing. A process for preventing decay of wood and fibrous materials or fabrics, patented in England by Burnett, 1837.

The wood or fiber is immersed in a solution of chloride of zinc, 1 pound; water, 4 gallons for wood, 5 gallons for fabrics, 2 gallons for felt, contained in a wooden tank.

Timber is saturated two days for each inch of thickness, and then set on end to drain for from two to fourteen weeks.

Cotton, yarns, cordage, and woolens are immersed for forty-eight hours.

Burn'ing. 1. (*Metal-working.*) Joining metals by melting their adjacent edges, or heating the adjacent edges and running into the intermediate space some molten metal of the same kind.

It differs from soldering in this: —

In burning, a heat is required sufficient to melt the original metal, and a flux is seldom used.

In soldering, a lower heat is used and a more fusible metal employed, assisted by a flux.

The superior quality of the former process arises from the fact that the joint will withstand the same heat as the body of the article.

It is apt to be stronger, as the article soldered has usually more tenacity than the solder; tin-plate or copper than the alloy of tin and lead, for instance.

The article *burned together* being homogeneous, the parts expand and contract evenly by changes in temperature; the solders have a greater range of expansion by given changes of temperature than the metals they connect.

The solders oxidize more or less freely than the metals they connect, and establish galvanic circuits which destroy the integrity of the joint; especially in the presence of heat, moisture, or acids.

As an instance, the leaden vessels and chambers for sulphuric acid cannot profitably be united with tin solder, as the acid acts so freely on the tin. The joint was therefore made by doubling the edges in a hollow lap and pouring red-hot lead on to the joint. This is now performed by *burning together*, the heat being applied by an airo-hydrogen blow-pipe. See BLOW-PIPE.

Pewter is *burned together* by a nearly red-hot soldering-bit, which melts a strip of pewter laid in the angle. Superfluous metal is filed off when cold.

Brass is burned together, as in the case of brass mural circles for observatories, that are from 4 to 6 feet in diameter, and are cast in six or more segments.

The ends of the segments are filed clean; two pieces are fixed vertically in a sand-mold, in their relative positions; a shallow space is left around the joint, and the entire charge of a crucible, say thirty or forty pounds of the melted brass, a little hotter than usual, is then poured on the joint to heat it to the melting-point. The metal overflows the shallow chamber or hole, and runs into a pit prepared for it in the sand, but the last quantity of metal that remains solidifies with the ends of the segments and forms a joint almost or quite as perfect as the general substance of the metal. The process is repeated for every joint of the circle.

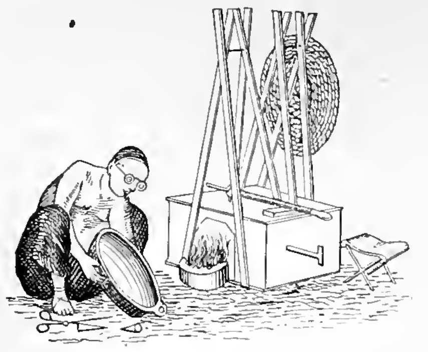
Cast-iron is also united by burning. It was first practiced by the native smiths of India and China, who occasioned much surprise to their Occidental neighbors by the way in which they mended cast-iron kettles and pots, which were supposed to be irretrievably ruined.

The first notice of it by Europeans appears to have been by Van Braam, in 1794–95, who was attached to the Dutch Embassy at Pekin, and who afterwards settled in the United States.

The figure represents the itinerant artist with his portable forge, at work in the street. The front half of the wooden chest is his *Fung-Seang*, or bellows. Its principle is that of the double-acting force-pump, and it is constructed wholly of wood, except the valves and packing of the piston, which are paper, and singularly durable. The long coarse file, with a prolonged smooth extremity to slide through a ring, fixed on the chest, is a common accessory to a tinker's budget. By the arrangement, he possesses a tolerably good substitute for a bench and vise, and can increase or diminish the pressure of the file on the object operated on, at pleasure.

The European plan for *burning together* cast-iron surfaces consists in using an excess of metal which is poured continuously through the fissure until the edges of the metal are in a semi-fluid condition,

Fig. 988.



Burning.

much as in the case of the brass mural circles previously mentioned.

As nearly analogous to the just-described processes, may be mentioned in this place the modes of uniting metal to metal by simple heat and contact.

A thin plate of silver and a stouter bar of copper, their surfaces being scraped perfectly clean, are tied together by a binding-wire and united by partial fusion without the aid of solder. The two metals are raised to a heat just short of the melting-point of silver, and when afterwards rolled the two metals maintain a perfect contact and the same proportional thickness however attenuated they may become.

The compensation balance of the chronometer and superior watches is another example of the union of metals by heat and contact.

The balance is a small fly-wheel made of one piece of steel, covered with a hoop of brass. Its principles and applications are described under BALANCE (which see). The two metals are thus united: the disk of steel, when turned and pierced with a central hole, is fixed by a little screw-bolt and nut to the bottom of a small crucible with a central elevation smaller than the disk. The brass is melted and poured into the crucible around the disk. When cooled, the crucible is broken, the superfluous brass is turned off in the lathe, the arms are made by the file as usual, and lastly, the hoop is divided in two places, at opposite ends of its diametrical arm.

A little black-lead is sometimes introduced between the steel disk and the crucible.

The airo-hydrogen blow-pipe, a modification of the oxyhydrogen blow-pipe invented by Dr. Hare, of Philadelphia, is used in melting the adjacent edges of metals so as to unite them by fusion, or in fusing strips of the same metal over a seam or joint where the edges of sheet-metal abut upon each other. See BLOW-PIPE.

2. (*Ceramics.*) The final heating of clay ware, which changes it from the *dried* or *biscuited* condition to the perfect ware. The glaze or enamel is applied to the *baked* ware, and is vitrified in the *burning*.

Burn'ing-glass. (*Optics.*) A convex lens of large size and short focus, used for causing an intense heat by concentrating the sun's rays on a very small area.

Pliny states that the ancients had globes of glass and crystal which produced fire, and Lactantius adds that a glass sphere full of water did the same.

Any convex lens may be employed as a burning-glass, its calorific effect, as in the case of a mirror, being proportional to the number of rays concentrated in a given area, or to the relative circular areas of the lens and the spot on which the refracted rays fall.

About 1774, M. de Trudano constructed a hollow glass lens, of 11 feet focus, filled with oil of turpentine, of which it held 140 Paris pints (nearly equal to the same number of English quarts). By this lens a bar of steel 4 inches long and ⅓ of an inch square was melted in five minutes. Three and six livre silver pieces were fused in a few seconds, and grains of platinum were melted sufficiently to cohere, but not to form a spherical drop.

The "Parker" lens or burning-glass was made in London at a cost of $3,500. It was of flint glass, 36 inches in diameter, double convex, its sides portions of a sphere of 18 feet radius. Its focus was 6 feet 8 inches; diameter of focus at that distance, 1 inch; weight, 212 pounds. A second lens, of 16 inches diameter and weight 21 pounds, was used to concentrate the rays, the focal distance being then 63 inches, the diameter of focus ½ inch. This lens was carried to China by an officer in the suite of Lord Macartney, and left at Pekin.

The effects of the burning arrangement were as follows: —

Substances.	Weight. Grains.	Time. Seconds.	Substances.	Weight. Grains.	Time. Seconds.
Gold (pure)	20	4	Carnelian	10	75
Silver (pure)	20	3	Jasper	10	25
Copper (pure)	33	20	Onyx	10	20
Platinum (pure)	10	3	Garnet	10	17
			Spar	10	60
Nickel	16	3	Rotten-stone	10	80
Bar-iron	10	12	Slate	10	2
Cast-iron	10	3	Asbestos	10	10
Steel	10	12	Limestone	10	35
Topaz	3	45	Pumice-stone	10	24
Emerald	2	25	Lava	10	24
Flint	19	30	Volcanic clay	10	60

See BURNING-MIRROR.

Burn'ing-house. (*Metallurgy.*) A miner's term for a kiln or roasting-furnace in which volatile mineral matters are expelled, as the sulphur from tin pyrites. A kiln.

Burn'ing-mir'ror. A concave mirror, or a combination of plane mirrors, so arranged as to concentrate the sun's heating rays on a common object.

The most celebrated of these are the mirrors of Archimedes, who thereby burned the Roman fleet of Marcellus at Syracuse. Each concave mirror was separately hinged, and they were brought to bear in combination upon the object in the common focus.

In Peru, previous to the Spanish Conquest, the rays of the sun were collected in a concave mirror and fire kindled thereby.

Besides the familiar instance of the burning of the fleet of Marcellus by Archimedes, another instance is cited by the historian Zonaras, who records that Proclus consumed by a similar apparatus the ships of the Scythian leader Vitalian, when he besieged Constantinople in the beginning of the sixth century. It must, however, be mentioned that Malaba, another old chronicler, says that Proclus operated on this occasion by burning sulphur showered upon the ships by machines.

Stettala, a canon of Milan, made a parabolic reflector with a focus of 45 feet, at which distance it ignited wood. It is understood to be the first of that form, though Digges in the sixteenth century, Newton and Napier in the seventeenth century, experimented with parabolic mirrors.

Villette, an optician of Lyons, constructed three mirrors about 1670. One of them, purchased by the King of France, was 30 inches in diameter and 36 inches focus. The diameter of the focus was about 1 inch. It immediately set fire to green wood; it fused silver and copper in a few seconds, and in one minute vitrified brick and flint earth.

The Baron von Tchionhausen's mirror, 1687, was a concave metallic plate 5 feet 3 inches in diameter, and having a focal length of 3½ feet. Its effects were similar to those of the mirror just cited, and it is recorded that slate was transformed into a kind of black glass, which, when laid hold of by a pair of pinchers, could be drawn out into filaments.

Buffon made a machine with 140 plane mirrors 4 × 3 inches, placed in a frame and separately adjustable by temper-screws. With 24 of the mirrors adjusted to a common focus at a distance of 66 French feet, he fired pitch and tow. With a polyhedron frame set with 168 pieces of plain looking-glass, 6 inches square, he fired beechwood at 150 feet, and melted a silver plate at 60 feet. He then constructed one on similar principles, with 360 mirrors 8 × 6 inches in a frame 8 × 7 feet. With this most metals were melted at 25 to 40 feet distance, and wood was burned at 210 feet distance.

Burn'ing-on. A process of mending castings by uniting two fractured portions, or by attaching a new piece to a casting.

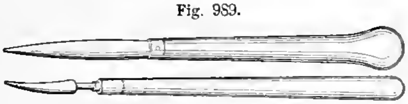
The casting is so fitted into a mold, in connection with a pattern, that the latter portion shall represent the piece required. The mold being opened, the pattern is removed and the mold reclosed, leaving the casting in position. Metal is then flowed through the mold until the face of the casting becomes softened, when the flow is stopped, and the mold allowed to fill in the usual manner.

When two castings are to be united, the molten metal is poured through a space between them until the respective surfaces become softened so as to unite fairly with the metal. The flow is stopped and the chink allowed to fill. It is then cooled in the ordinary manner. See BURNING.

Bur'nish-er. A tool for smoothing or pressing down surfaces to close the pores or obliterate lines or marks.

The engraver's burnisher is made of steel, elliptical in cross-section, and coming to a dull point like

Fig. 989.



Engravers' Burnishers.

a probe. The larger one in the figure is the ordinary form, and the smaller one is used by stipple-engravers.

Burnishers are often made of dogs' teeth (the canine tooth), which is of a convenient shape and size for some purposes, and, like other teeth, has a very hard enamel.

They are also sometimes made of agate, which is an extremely hard mineral, and is useful in burnishing paper for collars. Paper is much more wearing than steel softened for the engraver or die-sinker, owing to the presence of silex in the fiber.

Burnishers of bloodstone are used for putting gold-leaf on china-ware.

Agate burnishers are used by bookbinders.

The gilder's burnisher is of agate or porphyry.

A round *broach* is used for burnishing pivot-holes.

For cutlers' use the burnisher is inlaid into a piece of wood with handles like a spoke-shave.

The *clog-burnisher* used by cutlers is inserted into a handle which has a ring and staple at one end, so that the left hand of the operator is free for handling the work.

For still larger work, the burnisher is at the bottom end of a pole suspended from the ceiling.

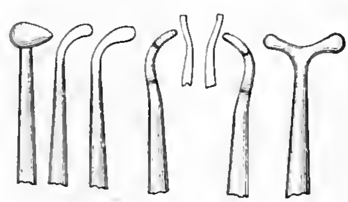
A flat-bladed burnisher is used in restoring the edges to the teeth of the comb-maker's files. These teeth are made by a file, not a chisel, and have a forward inclination of 15°.

A round burnisher is also used to restore the edge to the steel scraper used by cabinet-makers in finishing surfaces, especially of veneers.

Also by the currier in preserving the wire-edge of his knife. Called a *steel*, and resembling an *awl*.

The dentist's burnisher has a bulbous, spherical, or probe-shaped termination for smoothing the surface of metallic filling of teeth.

Fig. 990.



Dentists' Burnishers.

Fig. 991.

Shoemaker's Burnisher.

The shoemaker's burnisher is for finishing the edges of boot-soles. In the example, the tool has a movable head and a metallic socket, so that the stock need not be injured when the head is heated for use. See BURNISHING-MACHINE.

Bur'nish-gild'ing. A mode of gilding consisting of the following processes: —

The stuff for picture-frames, looking-glasses, etc., or other object to be gilt, is —

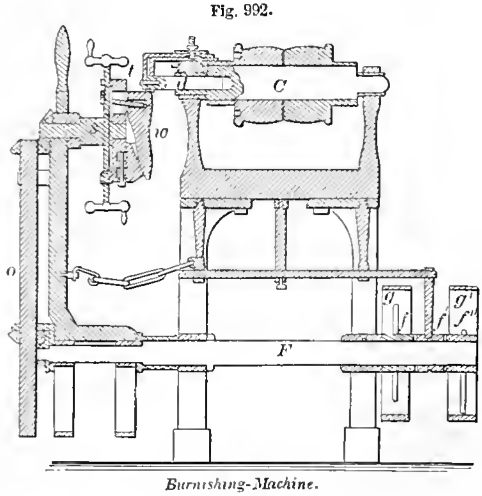
Primed with white stuff in several coats. This consists of hot size and whiting.

The surface is smoothed with pumice-stone and glass-paper.

It then receives a number of coats of a peculiar size, formed of pipe-clay, red-chalk, black-lead, suet, and bullock's blood, thinned with a solution of gelatine.

On this the gold-leaf is laid and burnished. See GILDING.

Fig. 992.



Burnishing-Machine.

Bur'nish-ing-ma-chine'. One for giving a polish by compression. Such are the machines for burnishing paper-collars and boot-soles. One of the latter is shown in Fig. 992.

The last *w* is secured eccentrically to the cross-head *t*, which receives motion from the shafts *s o F* and band-wheels *g g'*. By means of a clutch *f f' f''* the motion may be reversed so that the boot-sole may be burnished to one shank and then turned back again. The burnishing-tool also revolves with its stock *d* and mandrel *C*, but is adjusted relatively to the boot-sole by sliding-gages which do not partake of the motion.

Burr. 1. The waste or refuse of raw silk.

2. A vitrified brick.

In a mechanical sense, see BUR.

Bur'ras-pipe. A tube to contain lunar caustic or other corrosive.

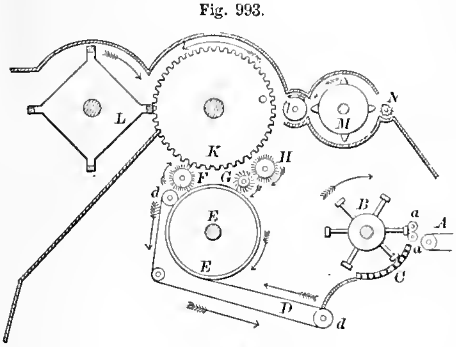
Bur'rel-shot. (*Projectiles.*) A medley of shot, stones, chunks of iron, etc., to be projected from a cannon at short range. Emergency shot. *Langrel.*

Bur'ring. (*Woolen-manufacture.*) A process in the manufacture of wool by which burs and foreign matters are removed from the wool, which has been opened by the preceding *willowing*-process.

Bur'ring-ma-chine'. A machine for *picking* and *burring* wool. It follows the *willowing* machine and precedes *carding.*

A *picking and burring machine* is exhibited in a section which displays the working parts. *A* is the feed-cloth by which the wool is carried into the machine; *a a* are two fluted iron rollers which draw in the wool, and it is then exposed to the action of

Fig. 993.



Burring-Machine.

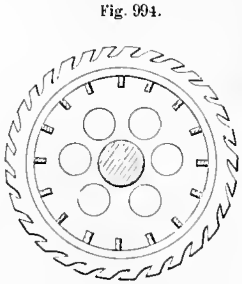
a heavy iron beater *B*, which, revolving in the direction of the arrow, beats and separates the wool and throws it down on the cloth *D*, while dust and dirt pass through the grating *C*. The cloth *D* has a chain fastened to each side, the links of which work into studs on the rollers *d d*, thus insuring regularity of motion; the loose wool is carried forward by this cloth under the wire cage *E*, which, pressing upon it, forms it into a loose lap or fleece. This is taken off the cloth by the brush *F*, and transferred by it to the comb-cylinder *K*, which has a number of fine iron combs, set longitudinally round its circumference. By the revolution of the cylinder the wool is carried on to the card-roller *G*, which takes it off the comb-cylinder, and is itself stripped by the brush *H*, the latter returning the wool to the large cylinder *K*, which then carries it forward to and against a steel blade or straight edge placed vertically at a very small distance from the comb-cylinder; the latter draws the wool through the narrow slit, but every bur, seed, or other foreign substance, is stopped by the plate. A roller *l*, covered with spiral blades, revolves against the plate, and carries off the arrested burs, together with any locks of wool which may be attached to them, and throws them back to the cylinder *M*, the teeth of which throw them back over the bars of a grating to a small fluted roller *N*, which delivers the lock of wool — by this time detached from the bur — down the sloping board.

The wool which has passed the opening at the plate is carried on by the combs till it is stripped off by the brushes fixed in the angles of a large prismatic roller *L*, which delivers it down the inclined exit-board.

Bur'ring-saw. A serrated wheel or blade which works in a burring-machine to seize the fibers of wool and draw them away from the burs, which cannot pass the opening through which the saw works.

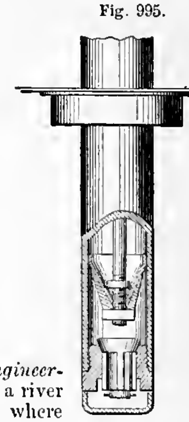
Bur'ring-wheel. A circular or annular wheel with serrated periphery, used in burring wool or ginning cotton.

Fig. 994.



Burring-Wheel.

Fig. 995.



Burr-Pump.

Bur'rock. (*Hydraulic Engineering.*) A small weir or dam in a river to direct the stream to gaps where fish-traps are placed.

Burr-pump. (*Nautical.*) A form of bilge-water pump in which a cup-shaped cone of leather is nailed by a disk (burr) on the end of a pump-rod, the cone collapsing as it is depressed, and expanding by the weight of the column of water as it is raised.

Burst'ing-charge. 1. (*Mining.*) A small charge of fine powder, placed in contact with a charge of coarse powder or nitroleum to ensure the ignition of the latter. It is usually fired by voltaic means.

2. (*Ordnance.*) The charge of powder required for bursting a shell or case-shot; it may be poured in loose, or placed in a *burster-bag.*

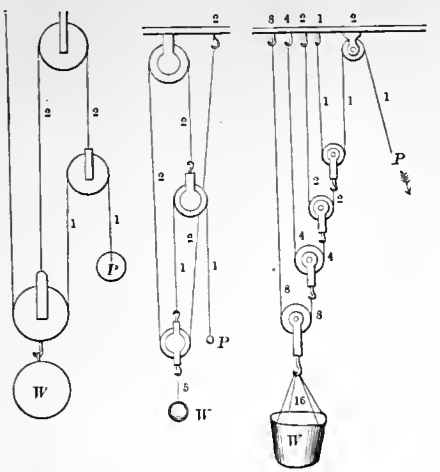
Bur'ton. A peculiar style of tackle. It has at least two movable blocks or pulleys and two ropes. The weight is suspended to a hook-block in the bight of the running part.

This arrangement of cords and pulleys is susceptible of great variation, so as to increase in a twofold, fourfold ratio, or otherwise. Each pulley has but one sheave, and there are as many ropes as movable pulleys. The numbers indicate the relative tensions of different cords. (Fig. 996.)

Bur'ton-tack'le. An arrangement of pulleys. See BURTON.

Burt's Nip'pers. An instrument used for keeping the line perpendicular in deep-sea soundings. It is suspended from a bag which floats on the surface, and the sounding-line is passed between a plate or spring and a roller, which allow it to run freely through in descending, but "nip" it when it strikes

Fig. 996.



Spanish Burton.

bottom and stops running or is pulled backward. It thus also indicates the precise up-and-down depth of the sounding.

Bush. (Fr. *bouche*, a mouth.) A bearing for a spindle or arbor, as in the case of the wooden chocks; called also *followers*, which surround the spindle within the eye of a bed-stone, and form the upper bearing of the spindle. A piece of metal or wood inserted into a plate to receive the wear of a pivot or arbor.

A *thimble, sleeve*, or hollow socket placed in a hole in a plate or block, and adapted to receive a spindle, gudgeon, or pivot. It forms a lining for a bearing-socket.

Old and worn pivot-holes are bored out, bushed, and a new pivot-hole drilled. The collar of a lathe-spindle is a bush. Gun-vents are bushed. Bush-metal is a bronze — copper and tin — used for journals.

The pivot-holes of the old-fashioned wooden clocks were bushed with box or pear-tree wood. Dogwood or apple-tree wood also affords good material for wooden bushing.

The circular guide in which a rod slides.

A circular piece of metal let into the sheaves of such blocks as have iron pins.

A collar around a piston-rod or a bearing in a shaft-hanger is sometimes called a bush. See Bushing.

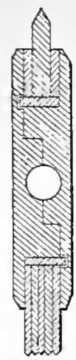
Bush-ex-tract'or. (*Husbandry.*) An implement for pulling out bushes and grubs. It usually consists of a lever having at its lower end a claw, clevis, or grapple, which pinches the stem of the bush against the lever, and then, the lever being depressed by rocking on its rolling shoe or axle, the latter forms the fulcrum, and the grub is torn up by the roots. It is of the nature of a claw-bar or cant-hook, or a pair of claws.

Bush-ham'mer. 1. The mason's large breaking-hammer.

2. The miller's hammer for dressing millstones. The steel bits are usually detachable from the sockets of the heads, to enable them to be dressed on a grindstone.

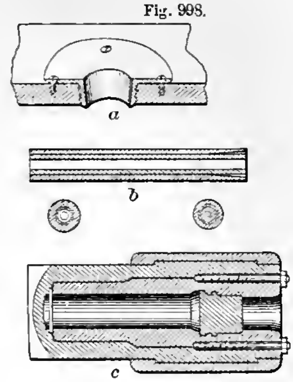
In the example the frame is made of two parts, with shoulders, and with cavities for bolts, and projections from the base for the support of the cutters which are socketed therein.

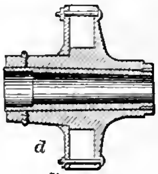
Fig. 997.



Bush-Hammer.

Fig. 998.





Bushings.

Bush-har'row. An agricultural implement consisting of a number of limbs or saplings confined in a frame and dragged over ground to cover grass-seed.

Bush'ing. A lining for a hole. Often called a Bush (which see).

a is a bushing for the bung-hole of a barrel.

b is a bushing to reduce the caliber of a gun-barrel; a taper tube is brazed in place at the end between the two, and makes all fast.

c is a breech-loading cannon, having a bushing secured by joint-screws and a reïnforce on the exterior.

d is a metallic hub with an inner bushing to form the axle-box.

Bush-scythe. A stout short scythe for cutting brush and briers.

Busk. A stiffening bone or plate in a corset, to maintain its shape and prevent its gathering in folds and wrinkles around the waist. The busk is made of wood, steel, brass, whalebone, or vulcanite.

Buss. (*Vessel.*) A two-masted fishing-vessel of from 50 to 70 tons burden. It has a cabin at each end.

"They have a designe to get the king to hire a docke for the herring busses to lie up in." — Pepys, 1661.

Bust. A statue of the upper part of the person, embracing the head, shoulders, and breast.

Lysistratus, the sculptor, is cited as the inventor of casting busts, etc., from molds, 328 B. C. Busts from the face in plaster of Paris were first taken by Andrea Verocchi, A. D. 1466. The plaster cast is made by pouring the fluid plaster around the head and face, which are previously well oiled, to prevent adhesion, the hair being protected by an oiled cap. When the plas-

Fig. 999.

Roman Knives, etc.

ter has partially set, and while it is yet in a soft state, the mold is divided into sections for removal by strings or fine wires previously arranged in the interior. Busts are now turned by machinery constructed on the principle of Blanchard's lathe for turning irregular forms, which was originally applied to turning gun-stocks and spokes for carriage-wheels.

Butch'er-knife. A knife for cutting meat. The tang of the blade is usually riveted between two *scales*, which form the handle.

The Roman butcher-knives, used also for sacrificial purposes, were wide at the hilt-end of the blade, and had sharp points. The pole-axe is also shown in the figure.

Next to the pole-axe is the *seva* or *secespita*, for cutting the throats of the animals. On the left is the *dolabra*, for dismembering. Below are the *cultri* or *cultelli*, for skinning and slicing.

But'ment-cheek. (*Carpentry.*) The part of a mortised timber surrounding the mortise, and against which the shoulders of the tenon bear.

Butt. The hinder, larger, or blunter end of an object; as of a gun, a connecting-rod, a crow-bar, etc.

1. The end of a *connecting-rod* against which the *boxing* is attached by the *strap*, *cotter*, and *gib*.

2. The end of an object where it comes squarely against another.

3. A joint where the ends of two objects come squarely together without scarfing or chamfering.

4. A form of door-hinge which screws to the edge of a door, and *butts* against the casing instead of extending along the face of a door, like the *strap*-hinge. It consists of two oblong plates, one edge of each of which is dentated to fit its fellow, a *pintle* traversing each interlocking portion to form a joint. See BUTT-HINGE.

5. *a.* A target.

b. A wooden structure, consisting of several thicknesses of boards, separated by small intervals, for the purpose of ascertaining the depth of penetration of bullets.

c. A frame of iron and wood, representing a large section of armor-plating, and moored in position for determining the destructive power of shot, shell, and given charges of powder.

d. A mound of earth to receive the bullets in the proof of gun-barrels.

6. (*Shipbuilding.*) The meeting-joint of two *planks* in a *strake*. The joint between two strakes is a *seam*.

7. The thick part of an ox-hide.

8. The standing portion of a half-coupling at the end of a hose.

9. The shoulder-end of a gun-stock covered with a heel-plate.

10. A large cask containing 126 wine gallons.

Butt-chain. (*Saddlery.*) A short chain which reaches from the leather tug to the single-tree, to each of which it is hooked.

But'ter. 1. (*Wood-working.*) A machine for sawing off the ends of boards, to render them square and to remove faulty portions.

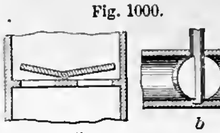
In the large saw-mills of the lumber-regions double butters are used, one saw being permanent and the other adjustable by a spline on a grooved mandrel, to adapt it for boards of varying lengths. The boards are laid upon parallel, traversing, endless chains, with dogs at intervals.

2. See CHURN.

But'ter-fly-cock. A valve having two semicircular wings pivoted on a central cross-bar. A butterfly-valve.

But'ter-fly-valve. A double clack-valve, each leaf of which is hinged to a bar crossing the passage-way, as in the examples annexed.

Fig. 1000.



Butterfly-Valves.

a, butterfly pump-valve.

b, butterfly throttle-valve.

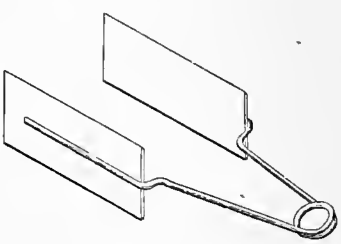
But'ter-is. (*Farriery.*) A knife with a bent shank, used by blacksmiths to pare the hoofs of horses. It has a blade like a chisel, and is operated by a thrust movement, the handle resting against the shoulder.

The term is probably from the French *boutoir*; Provincial, *boutavan*. Some old Roman paring-implements of iron are yet extant.

But'ter-mold. (*Husbandry.*) An implement by which pats of butter of a given size are shaped and printed for market.

Butter-tongs. An implement for cutting and transferring pieces of butter. In Fig. 1001 the blades are attached to shanks which unite in a spring coil, so as to separate them when not in actual use.

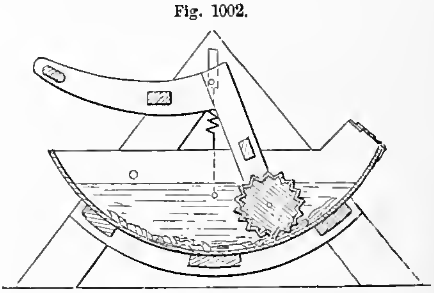
Fig. 1001.



Butter-Tongs.

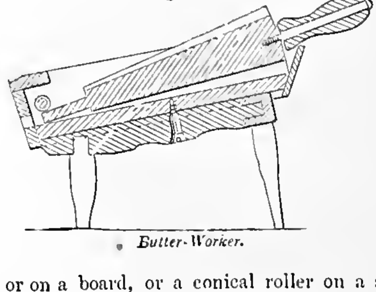
But'ter-work'er. (*Husbandry.*) An implement for pressing and rolling butter to free it of the buttermilk. It may be a fluted roller working in a bowl or on a board, or a conical roller on a slanting board which permits the buttermilk to run off.

Fig. 1002.



Butter-Worker.

Fig. 1003



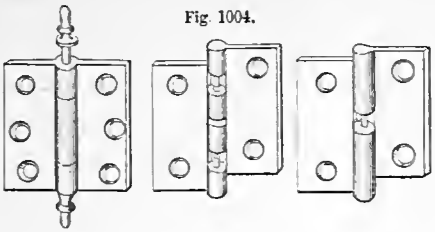
Butter-Worker.

Butt-how'el. (*Coopering.*) A howeling-adze used by coopers.

Butt-hinge. A hinge formed of two plates and interlocking projecting pieces which are connected by a *pintle.*

The *butt*-hinge is so called because, instead of fastening on the faces of the door and jamb like the ancient hinges, the leaves are secured to the door and casing at points which *abut* upon each other.

Fig. 1004.



Butt-Hinge.

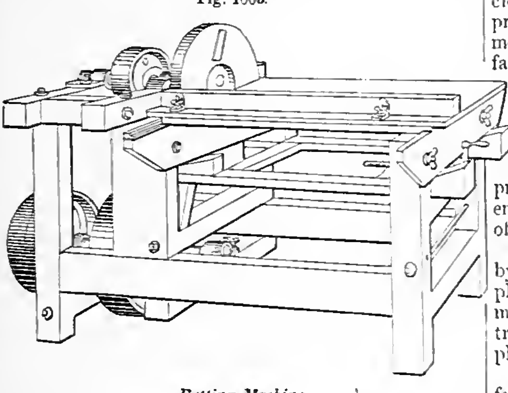
A *rising butt* is one in which the leaf attached to the door ascends as the door is opened, an incline on one leaf climbing on the incline of the part it rests on, so as to give to the door a tendency to descend and close in so doing.

The following names are known in the trade: —

Broad butts.	Wrought-butts.
Narrow butts.	Table-butts.
Loose-joint butts.	Fast-joint butts.
Reversible butts.	Acorn-tipped butts.
Shutter-butts.	Congress-butts.

But'ting-ma-chine'. A machine having planing-cutters on the face of a disk-wheel, and used for smoothing, cornering, or rounding the ends of joists or small timbers used in the frames of agricultural implements, etc. The stuff is laid alongside the fence or gage, and is fed up endwise to the cutter.

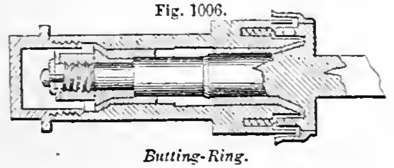
Fig. 1005.



Butting-Machine.

But'ting-ring. (*Vehicle.*) A collar on the axle against which the hub *butts,* and which limits the inward movement of the wheel, as the linch-pin or axle-nut does the outward. In the example, a butting-flange on the axle enters a groove in the inner end of the box, and abuts against springs whose elasticity lessens the jar when the wheel plays longitudinally on its spindle.

Fig. 1006.



Butting-Ring.

But'ting-saw. A cross-cut saw attached to a stock at one end, and used for butting logs on the carriage of a saw-mill. Many logs are brought to the mill with the slanting kerf given by the axe in felling or logging. To *butt* a log is to cut or saw it off square at the end, so that it may lie safely upon the rabbet of the head-block in any position, and be readily held by the dogs. The action of this saw is that of a *drag*-saw.

Butt-joint. A joint in which the pieces come square against each other, endwise. In iron work the parts are welded, and the term is used in contradistinction to a *lap*-joint or weld.

But'tock. (*Shipbuilding.*) The rounded-in, overhanging part on each side and in front of the rudder; terminating beneath by merging into the *run.*

But'tock-lines. The curves shown by a vertical longitudinal section of the after-part of a ship's hull, parallel to the keel. A similar section forward exhibits the *bow*-lines, and a continuous section through the whole length of the ship the *buttock* and *bow lines.*

But'ton. 1. A small circular disk or knob with a shank for attachment to an object, and forming, in concert with an opening in another object, or another side of the same, a means of fastening the two together.

The ancient modes of fastening dresses were pins, brooches, buckles, and tie-strings.

Iron, steel, brass, copper, pewter, lead, gold, silver, horn, shell, pearl, tortoise-shell, ivory, bone, hoofs, hair, silk, cotton, linen, Florentine, gutta-percha, india-rubber, vulcanite, amber, velvet, cloth, glass, porcelain, wood, enamel, jet, compressed earth, clay, precious stones, are among the most prominent substances employed in the manufacture of buttons.

Buttons of brass are noticed on dresses of the tenth century. About 1670 the metallic button-manufacture of England took its rise.

A manufactory was established in Birmingham, England, 1689, and that city still maintains a preëminence in this manufacture, as in so many others, employing no less than 4,981 persons in this branch of industry alone, according to the census of 1851.

Metallic buttons with shanks are usually made by punching the disks forming their faces out of a plate of sheet brass containing less zinc than common brass; the edges of the disks are afterwards trimmed to remove the bur, and their faces are planished under the action of a hammer.

The maker's name is stamped on the back and the face embossed at one operation, by means of cameo and intaglio dies.

The shanks are made of wire by a machine; a shears cuts off a piece of suitable length from the coil; a stud then presses against the middle of the cut piece, and forces it between the jaws of a vice, which give it a staple-like form, compressing it so as to form the eye of the shank; it is then struck by a small hammer, which makes it level, and another movement drops it into a box.

The shanks are then placed in their proper positions on the disks, being retained by a bent, flat strip of iron, a piece of solder being placed at the foot of each shank. A hundred or more are then put on an iron plate and heated in an oven until the solder melts, fixing the shank and forming a backing to the button. They are then turned separately in a lathe adapted for the purpose, and, if desired, gilt, which operation was, previous to the electro-plating process being perfected, performed by coating the brass disk with an amalgam of mercury and gold, the former of which was afterward driven off by heat.

When the face only is gilt, the buttons are technically known as *tops*, but when gilding is applied to the whole surface they are termed *all-overs*. The gilding, though extremely thin, admits of being brightly polished by means of an agate or bloodstone burnisher.

Gilt buttons first made by Taylor, of Birmingham, England, 1768. Manufacture improved, 1790.

Metallic buttons without shanks are formed by stamping; those of wood, bone, etc., are turned; the holes, of which there may be two or four for attaching the button to the garment, are drilled while the button is in the lathe by means of four long drills converging toward the button, forming all four of the holes at once.

Cast buttons are made by taking a large number of impressions in a mold and inserting in each the loop of metal, whose expanded ends project into the mold and are surrounded by the metal of the button. The buttons, being cleaned from the sand, are chucked and turned, when they may be tinned, silvered, or gilded, as required.

Papier-maché buttons were made in 1778.

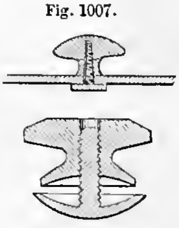
Mother-of-pearl buttons are cut out of the shell by means of a small cylindrical saw. The disks are turned in a lathe, and if the shell be sufficiently thick it is split so as to form two buttons. A dovetail hole is drilled for the shank, which is fixed by a slight blow with a hammer, its lower part expanding into the dovetail, so as to prevent its being readily withdrawn. The ornamental flutings and corrugations when present are formed in the lathe by means of an eccentric chuck and slide-rest.

A number of patents for making covered buttons, which are in such extensive use for outer garments, have been taken out in England since the first patent of Sanders in 1809; but the general principles of construction of the more important kinds may be reduced to two: in one of these a metallic disk or *shell* is stamped out of thin sheet-iron, for the face part, and a smaller *disk* or *collet*, having a perforation for the shank to pass through, is stamped out in like manner for the back. A circular piece of the textile fabric to be used is cut out by a die, and a pad of similar shape, commonly made of soft paper, silk, and thread is formed, which fills up the vacant space between the two metallic disks. The parts — namely, the two disks, the pad and the circular piece of linen, silk, or other material forming the face — are united to constitute the finished button by means of a stamping-press and appropriate convex and concave dies. The shank, of soft material through which a needle can be passed, protrudes at back through the aperture in the collet.

In the other plan, the disk for the body is left flat, and the back piece is a small circular disk with a round hole in its center, and having its edge cut into eight sharp triangular points, which are so bent as to form nearly a right angle with the disk, inclining slightly inward. To complete the button three pieces of paper and two pieces of cloth are necessary, which are arranged in the following manner.

On the piece of cloth forming the outer covering is laid a piece of paper of the same size, upon which is placed the iron disk forming the body; on this is another piece of paper the same size as the body; on this is a small pellet of paper to help form the shank; a piece of coarse cloth is laid on this, and the metallic back placed over it. In putting on the back, the cloth is gathered up over the whole of the materials and the points of the back pressed into the cloth; as these are bent slightly inward, the pressure causes them to bend still more as they enter the cloth, forming eight little hooks, which hold the button together in a neat and effectual manner; the paper pellet causes the cloth to protrude through the hole in the back, forming the cloth shank by which the button is sewed to the coat.

Fig. 1007.



Self-Fastening Buttons.

Fig. 1007 shows two forms of self-fastening buttons, having screws which pass from the rear of the material into the shanks.

2. (*Carpentry.*) A small piece of wood or metal, swiveled by a screw through the middle, and used as a fastening for a door or gate.

A knob on a sliding-bolt.

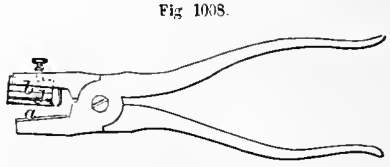
3. (*Metallurgy.*) A globule of metal remaining in the cupel after fusion.

But'ton-brace. A tool for making buttons. The handle is like the common brace; the bit has cutters, but no router, and removes a circular blank or planchet of bone, pearl, wood, or whatever the material may be; an *annular bit* operating like a crown-saw or trephine.

But'ton-hole Cut'ter. A device on the shears principle, specially adapted for cutting button-holes; the variations in construction principally relate to means for adjusting the length of the cut, and its angle with the edge of the cloth.

In Fig. 1008, the cutter *d* may be approached toward the center of motion, so as to cut its whole length, or projected outwardly so that its edge may only partially bear against the jaw *a*, to make a shorter cut.

Fig. 1008.



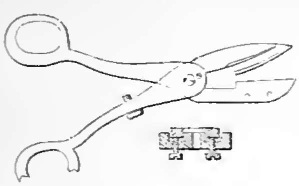
Button-Hole Cutter.

But'ton-hole Sew'ing-machine. In working button-holes by machinery, it is common for the perforating-needle to descend first through the material back from the slit, and then through the slit, or else a thread may be carried from the under side up over the edge of the material, and be locked by the needle in its next descent. The needle may be made to descend through the material and through the slit, by moving the material laterally, as well as forward by the feed, as in patent to Miller, March 7, 1854; or the needle-carrying box may be moved laterally after each stitch, by means of a cam, as in patent to Humphrey, October 7, 1862. The needle-thread is locked at each descent by a second thread carried by either a looper or a shuttle. In patent to Sleiner, June 19, 1860, the needle and shuttle operate as in an ordinary machine, but after the shuttle has passed through the loop of needle-thread, a hook catches its thread and passes it in the form of a loop up through the button-hole slit and spreads it in the path of, and the needle enters it at its next descent.

In patent to Rehfuss, May 23, 1865, the needle descends through the material back from the slit, a looper passes its thread through the loop of needle-thread, and then passes up through the slit, where its loop is caught by a hook, and spread in the path of the needle, which enters it at its next descent. Other methods of working button-holes have been attempted, but not found practicable.

Button-hole Shears. A scissors having an adjustability for length of cut, for the purpose of cutting button-holes. In one example, a set screw on one part of the shears bears against a washer on the other portion, to regulate the relative lateral adjustment of the two parts.

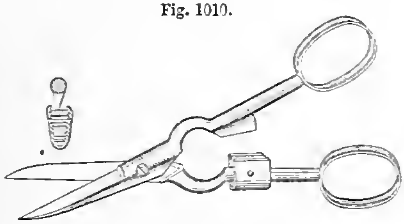
Fig. 1009.



Button-Hole Cutter.

In the other example, the button-hole cutter is attached to the shank of the shears.

Fig. 1010.



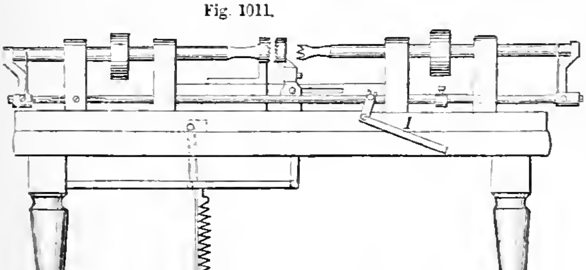
Button-Hole Shears.

But'ton-hook. A hook for grasping a button below the head, in order to draw it through the button-hole and fasten it.

But'ton Key or Fas'ten-er. A spring loop, the free ends of which, being passed through the shank of a button, expand so as to hold the loop in position and keep the button in place. A piece of coiled wire, making two or more turns, is also used for this purpose.

But'ton-lathe. A machine for cutting round disks for buttons. The material consists of plates of horn, bone, ivory, wood, mother-of-pearl, etc. The

Fig. 1011.



Button-Lathe.

cutter is like a center-bit, except that both of the wings are *cutters*, and not one of them a *router*. The tool revolving, the center-pin transfixes the stuff, and the wings make a circular cut, cutting out a disk of the material, which is advanced to the cutter by a sliding bar in the back poppet-head.

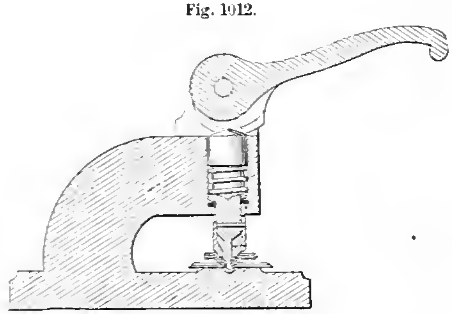
In the example, the moving jaw of the clutch is forced against the blank by a spring, and drawn back by depression of the treadle. The bits are brought singly and alternately against the blank, being moved thereto by the bell-crank hand-lever.

But'ton-loom. (*Weaving.*) A loom for weaving button-blank coverings.

But'ton-mold. A disk of bone, wood, or metal, to be covered with fabric to form a button.

But'ton Riv'et-ing-ma-chine'. A tool for fastening buttons to garments by swaging down on the back of the washer the end of the rivet which forms the shank of the button. In the example the

Fig. 1012.



Button-Riveting Press.

plunger is pointed, rotates as it descends, and spreads the end of the rivet. A sleeve on the plunger fits the hollow in the face of the button, and the flanged head of the rivet is bent over toward the fabric, which is thereby clamped against the convexity of the button.

But'ton-tool. A tool for cutting out buttons or circular blanks therefor. An annular bit. See BUTTON-LATHE.

But'tress. 1. (*Masonry.*) *a.* A pier or lean-to pillar on the exterior of a wall, to enable it to withstand an interior thrust, as in the case of a retaining or breast wall.

b. A flying buttress is one which is in the form of a section of an arch, springing from a wall or pillar.

2. (*Fortification.*) A counterfort or sustaining wall or pillar, built against and at right angles to the wall to which it forms a revetment. See COUNTERFORT.

Butt-weld. (*Forging.*) A weld in which the edges are square-butted and jammed against each other, and then welded. A *jump-weld.*

Buzz-saw. Another name for the circular saw, derived from the buzz or hum incident to the high speed at which it is run. See CIRCULAR SAW.

By'ard. (*Mining.*) A leather breast-strap used by miners in hauling the wagons in coal-mines.

Bye-wash. (*Hydraulic Engineering.*) *a.* A channel to divert past a reservoir water of streams which would otherwise flow with it, and which are impure or otherwise undesirable. Called also a *diversion-cut.*

b. The outlet of water from a dam. A *waste.*

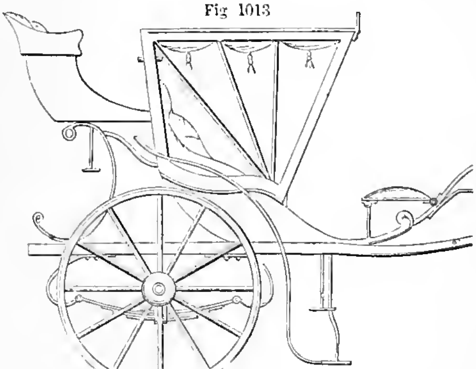
Bys'sa. (*Fire-arms.*) An ancient form of cannon for throwing stones.

C.

Caam. The weaver's *reed*. The *sley* or *slaie*. *Caaming*, the *setting* of the *reed* by the disposing of the warp-threads.

Cab. 1. A two or four wheeled, one-horse, closed vehicle, adapted to seat two persons inside, and having an elevated seat for the driver in front. The hanson-cab has a seat behind for the driver. The cab of Pickwick's time had two wheels and an outside seat on the right side, over the wheel. In the one shown, the driver's seat behind the body of the

Fig 1013



Cab

cab rests on a spring, and is supported on the rear extension of the frame of the vehicle. It has a supplementary seat next the dash-board, and also an opening in the back of the cover to permit communication between the driver and passenger.

Cabs were introduced into London for hire, 1823. Fifty were first started; there are now 7,000 in that city.

2. The covered part in front of a locomotive which protects the engineer and fireman, and shields the levers, etc.

Cab'bling. (*Metallurgy.*) A process of breaking up pieces of flat iron, to be fagoted, reheated, and rolled.

The series of processes are as follows: —

1. The pig-iron is treated in a refining-furnace.
2. The *loop* is forged.
3. Melted in contact with charcoal, and worked with a *rabble*.
4. *Tilted;* making a flat, oval plate.
5. *Cabbled;* that is, broken up into pieces.
6. *Fagoted.*
7. Reheated in a reverberatory furnace.
8. Hammered.
9. Rolled.

Ca-be'ca. (*Fabric.*) The finest kinds of India silk, as distinguished from the *bariga*, or inferior kind. *Cabesse.*

Cab'i-net-file. A smooth, single-cut file, used in wood-working, especially by furniture-makers and joiners.

Cab'i-net-or'gan. (*Music.*) A superior class and size of reed organ.

Ca'ble. 1. The strongest kind of rope, chain, or cluster of wires designed for holding a ship at anchor, for supporting the roadway of a suspension-bridge, for mooring, warping, and for other purposes.

Cables for supporting suspension-bridges were formerly made of a number of wire ropes, each of which consisted of wire twisted into strands. Suspension-bridge cables are now made of separately stretched steel wires, each of which is brought to a certain strain, and the bunch bound up into a cable, wrapped, parceled, and then served with wire and painted.

Submarine cables for telegraphic purposes have an interior core of copper wire surrounded by wires twisted after the manner of a rope, the whole being protected by a non-conducting waterproof coating of gutta-percha or india-rubber.

A large cable-laid rope is thus made: —

Hemp is laid up *right-handed* into *yarns*.

Yarns are laid up *left-handed* into *strands*.

Three *strands* are laid up *right-handed* into a *hawser*.

Three *hawsers* laid up *left-handed* make a *cable*.

See Rope.

Below ten inches in circumference, a rope is called a hawser.

Cables or ropes are —

Served; bound with rope, marline, or other small stuff, to prevent chafing.

Spliced; united by working the yarns or strands of the two portions together.

Parceled; wrapped with tarred canvas.

Wormed; having the spiral crevices between the lays filled with strands; usually a preliminary to *serving*.

A *cable's length* is 120 fathoms = 720 feet.

A *stream* cable is a hawser for mooring.

To *bit* the cable, is to wind it around the *bitts*.

To *buoy* the cable, is to support it by floats which keep it clear of the ground in a rocky anchorage.

To *coil* the cable, is to dispose it in helical tiers.

To *cut* the cable, is to sever it by an axe, or by unshackling, in *club-hauling* or to save the time necessary for *weighing*.

To *drag* the cable, is to haul it in the wake of the vessel.

To *fleet* the cable, is to allow it to surge back on the *whelps* of the capstan or windlass, as the cable climbs on to the larger part of the cone.

To *heave* the cable, is to haul in aboard.

To *nip* the cable, is to stop the running out by a pinching-rope, clamp, or lever.

To *pay out*, is to allow the cable to run out.

To *serve* the cable, is to wrap it with ropes to keep it from being chafed.

To *slip* the cable, is to let it run clear out, thus losing the cable.

To *stopper*, to fasten to the bitts.

To *unbend*, to detach from the anchor.

To *underrun;* with hempen hawsers, to take on board on one side of a boat and pay out on the other, examining and cleansing.

To *veer* a cable, to allow it to run out, keeping command over it.

A *kink* is a short turn in a cable which prevents its running through the hawse-hole.

Ships' cables were anciently made of flax, papyrus, or spartium; more lately of hemp or coir, but now usually of iron links.

A hempen cable of 12 inches girth and 120 fathoms (720 feet) long, weighs 3,075 pounds.

The weight of a hempen cable (120 fathoms) may be ascertained by multiplying the square of the girth in inches by 21. The product is the weight in pounds, nearly.

The breaking-strain may be found by dividing the weight in pounds by 100; this gives the breaking-strain in tons.

2. A molding representing a cable or spiral scroll.

Ca'ble-buoy. (*Nautical.*) A floating object secured by a rope to an anchor, to denote the position of the latter.

Ca'ble-grip'per. A lever compressor over the cable-well, and by which the cable is stopped from running out.

Ca'ble-hook. 1. A hook for attachment to the *messenger* by which the cable is hauled in on a man-of-war, or other ship having a large number of hands, without having recourse to the capstan. It may also be attached to a hawser, for underrunning the cable.

2. A hook by which the cable is handled. Each seaman has a hook in *lighting-up* the cable or packing in tiers.

Ca'ble-laid. Heavy rope, laid up cable-wise. See CABLE.

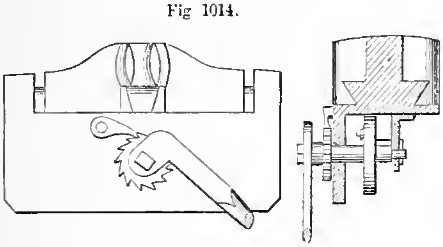
Ca'ble-mold'ing. A bead or torus molding, cut in imitation of the twisting of a rope, much used in the later period of the Norman style.

Ca'ble-nip'per. (*Nautical.*) A device serving to bind the *messenger* to the cable, and composed of a number of rope-yarns or small stuff marled together.

Ca'ble-shack'le. A D-shaped ring or *clevis*, by which one length of cable is connected to another, or, upon occasion, the cable connected to an object, such as the anchor-ring.

Ca'ble-stop'per. (*Nautical.*) A device to stop the paying out of the cable. In the example, a

Fig 1014.



Cable-Stopper.

pair of jaws slide on the rail, being moved simultaneously by an eccentrically slotted wheel and a lever.

The rope is passed around the pin and clamped by both jaws.

Ca'ble-tier. (*Nautical.*) *a.* A coil of a cable. A *fake;* one layer of cable as it lies in a tier.

b. A cable-locker.

Ca'bling. (*Architecture.*) A round molding, frequently used in the flutes of columns, pilasters, etc.

Ca-boose'. 1. (*Nautical.*) A small house on deck in which the cooking is done on a merchant-vessel.

2. (*Railway Engineering.*) A car attached to the rear of a freight train, fitted up for the accommodation of the conductor, brakemen, and chance passengers.

Cab'ri-o-let'. A vehicle for hire introduced from France into England in 1823. Shortened into *cab* (which see).

Cab'urn. (*Nautical.*) Spun rope-yarn for *seizing, worming*, and similar uses.

Ca-ca'o-mill. A mill for grinding the nut of the *theobroma cacao*, to reduce it to the condition of *flake cacao*. It differs from chocolate in being ground with a portion of its hull, instead of being carefully hulled before grinding. It is mixed in the hopper with flour, sugar, etc., and passed through a number of steel mills resembling paint-mills, by which the nut is reduced and the ingredients intimately incorporated therewith by means of friction, heat, and the oil evolved from the nut.

The *Theobroma cacao*, "Food for the gods," so named by Linnæus, from which cacao, broma, and chocolate are made, is grown in Caraccas, in the sheltered valleys, 500 feet above the level of the sea. The Mexican name is *cacauatl*. The tree is 20 feet in hight, and frequently planted with intermediate rows of coffee-trees, to shelter the young cacao-trees from the scorching heat. The crops are gathered in December and June, and a well-bearing tree will produce from 20 to 30 pods, which are gathered in a period of three weeks or so, as they turn yellow. After being allowed to lie in heaps for a time to farther ripen, the pods are opened, the pulp removed, and the beans spread on mats in the sun. As they dry, each obtains a hard, thin skin, and is of the size of a kidney bean. The next processes are those of the manufacturer, who commences by roasting the nuts and removing the husks.

Ca-cha-ra'do. (*Fabric.*) A kind of Spanish linen.

Ca-dene'. A common kind of carpet, imported from the Levant.

Cad'mi-um. Equivalent, 56; symbol, *Cd.*; specific gravity, 8.65; fusing-point, 450° F. A white metal resembling tin in appearance and zinc in properties.

Its use is as an ingredient in alloys.

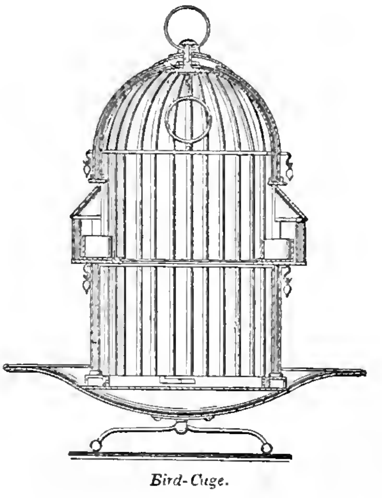
Cad'rans. An instrument for measuring the angles in cutting and polishing gems. See ANGULOMETER.

Caf'fa. (*Fabric.*) A kind of painted cloth goods manufactured in India.

Cag. A small cask used for packing herrings and other provisions. A *keg*.

Cage. 1. The prison of a bird or other animal. It is usually made of wire, sometimes of wicker, slats, splints, or strips of metal.

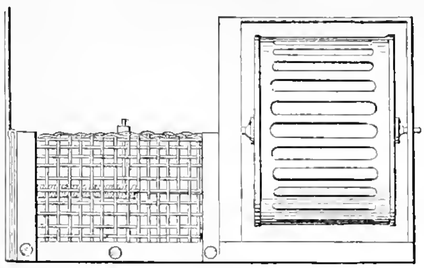
Fig. 1015.



Bird-Cage.

Those for squirrels or mice have usually a dormitory at one end, and a cylinder in which the animal is supposed to amuse himself by running without making any progress. In the example, the bars of

Fig. 1016.



Squirrel-Cage.

the tread-wheel are made by cutting slots in a sheet of metal subsequently bent to a cylindrical shape.

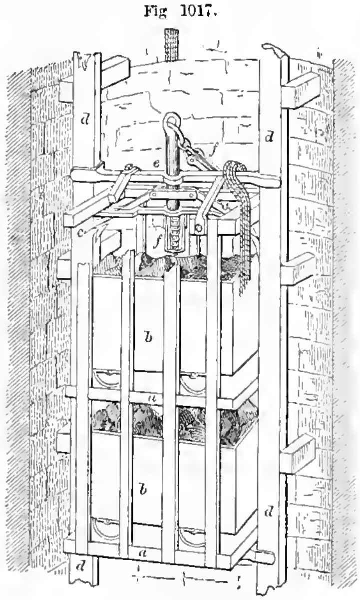
2. (*Mining.*) *a.* The platform on which trundles or hutches are raised or lowered in a shaft.

In coal-mining, the *hutches* or low-wheel cars are loaded and brought to the foot of the shaft, where from one to four are placed on the cage to be elevated. Arrived at the top, the cage rests on the folding-boards, which open before it and then shut automatically beneath it. The *hutches* are then run off, dumped, and returned to the cage, to be lowered again. See HOISTING-MACHINE.

Provision is made to stop the cage in case of the breaking of the hoisting-rope, and also to prevent its over-winding.

The safety-cage shown in Fig. 1017 runs on vertical guides, and has a cover to protect the men from falling objects. It has a spring *f*, which bears down the rod *e* to which the rope is attached. In case the

Fig 1017.



Safety-Cage.

hoisting-rope breaks, the spring forces apart the two jaws *c c*, whose claws catch into the wooden guide-bars *d d*, and arrest the downward course of the cage. *b b* are coal-hutches on the platforms *a a* of the cage, and the illustration shows the rope as broken and the descent arrested.

b. The trundle-wheel of a whin on which the rope is wound. Also called a *drum* or a *turntree.*

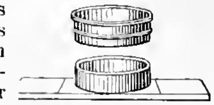
3. (*Machinery.*) *a.* A skeleton frame to confine a ball-valve within a certain range of motion.

b. A wire guard placed over an eduction-opening, to allow liquid to pass, but restrain the passage of solids.

4. (*Carpentry.*) An outer work of timber for inclosing another work, as the cage of stairs.

5. For microscopic objects in water, a cup having a glass bottom and cover, between which a drop of water containing animalculæ, or other minute objects, is placed for microscopic examination, in order to prevent their escaping beyond the focus of the microscope.

Fig 1018.



Animalcule-Cage.

Ca-hier′. (*Bookbinding.*) A pile of gathered sheets; the successive numbers of a serial.

Ca-ique′. A boat used on the Bosphorus.

Cais′son. 1. A carriage accompanying a field-piece to carry ammunition, and participating with it in its maneuvers, forming in line in the rear of its piece when the latter is in action. The name *caisson* is also applied to an ammunition-chest. See GUN-CARRIAGE.

2. A water-tight structure or bag placed beneath a sunken vessel, and then either supplied with air by pumping out the water and allowing air to enter, or distended by air from an air-pump, so as to assist in floating the vessel.

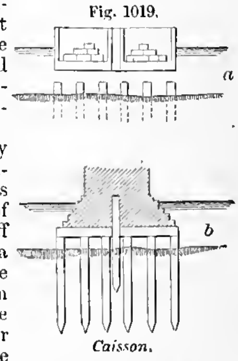
3. A water-tight box or casing used in founding and building structures in water too deep for the coffer-dam; such as piers of bridges, quays, etc.

The caissons employed in building the piers of the railroad bridge over the Susquehanna at Havre de Grace, Md., are an example of the use in the first-mentioned capacity.

Caissons resting upon a river-bed subject to washing have proved to be unsafe, as was evinced at Westminster Bridge, where the caisson was undermined by the current; the structure was saved by sheet-piling and underpinning.

The plan adopted by Peronnet and other eminent French architects was to drive a substratum of piles, which were sawn off to a level surface, forming a foundation for the structure which settled the caisson on its bed of piles as the masonry progressed. For the purpose of securing the coincidence of the caisson and its bed of piles, one of the latter was allowed to project upwardly, as high as the top of the caisson, occupying a well or water-tight curb which was open at each end. The long pile formed a guide, causing the caisson to settle correctly into position. The guide-pile has been occasionally used, but is by no means a necessary feature of the work.

Fig. 1019.



Caisson.

When the work is concluded, the sides of the caisson are knocked away, leaving the pier in position, as shown in the illustration.

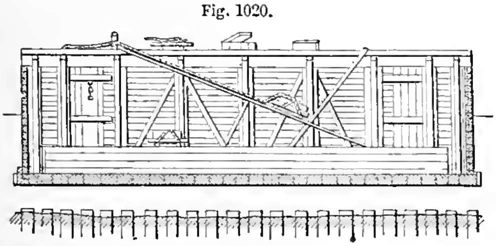
a represents the sinking of the caisson.

b, the pier on its foundation.

The caissons used by De Cessart in 1757 for the piers of the bridge at Saumur were sunk upon a foundation of piles, the heads of which were previously cut off to a level of about six feet below the water-surface. Each caisson was 48 × 20 feet, the ends being pointed and the sides removable, so that they could be used with another bottom after the masonry was laid nearly to the water-line. The bottom had a floor of lower beams laid side by side, and planks 14 inches thick, and the frame timbers were rabbeted to receive the uprights of the sides, which were secured to the bottom framing by dovetails and wedges, so that, the latter being withdrawn, the sides were disconnected.

The sides were 16 feet high, of scantling laid on edge and maintained in position by uprights, secured by struts and overhead braces, so as to resist the pressure of the water, and also by lap-joints and uprights at the angles of the caisson, the whole carefully calked. The caisson was built on the bank of the river upon piles cut to three different hights above the water; by blocking up, its bottom was kept level while building, and by removing these blocks, and with the aid of jacks, it was tilted so

Fig. 1020.



Caisson.

as to slide readily into the water, when it was towed into position, and the masonry laid until it sunk squarely on the heads of the piles previously driven for its reception.

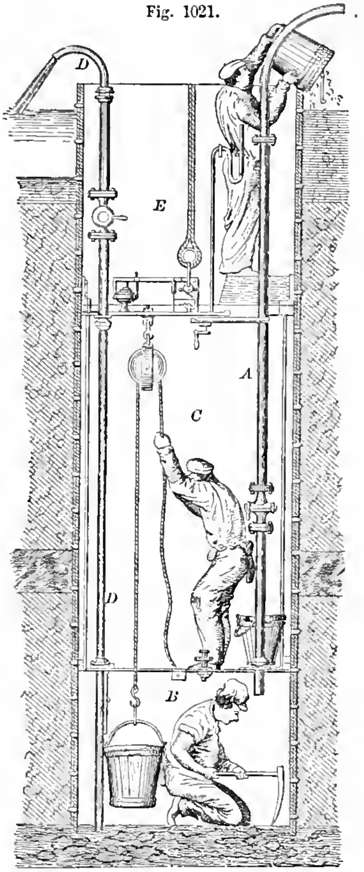
The modern or pneumatic caisson, which is sunk through quicksands or submerged earth or rock, is the invention of M. Triger, who contrived by the aid of air-pumps to keep the water expelled from the sheet-iron cylinders, which he sunk through quicksands in reaching the coal-measures in the vicinity of the river Loire, in France.

The seams of coal in this district of France lie under a stratum of quicksand from 58 to 66 feet thick, and they had been found to be inaccessible by all the ordinary modes of mining previously practiced.

Fig. 1021 illustrates the caisson of M. Triger, and shows the comparatively simple form which the apparatus assumed when used for sinking a simple shaft through a water-bearing stratum above the coal. Air is forced in through the pipe *A* to the working-chamber *B*, which has a man-hole in the floor above. *C* is the middle chamber, which has also a man-hole in its ceiling. *D* is a pipe by which sand and water are ejected from chamber *B*, under the pressure of the condensed air in the latter. The pressure of air in chamber *B* being such as to exclude the water, the workman descends through the man-hole in the floor of chamber *E* and closes the door behind him. Admitting air from chamber *B* until the pressure is equal in the two, he opens the door in the floor of chamber *C* and descends to his work. The buckets are similarly managed, the middle chamber *C*, acting as the means of communication, being filled with air at normal pressure, or with compressed air, according as it is in communication with the open air of chamber *E* or the condensed air of chamber *B*. The device which thus acts as an intermediate is termed an air-lock, and is the notable point of invention in the apparatus.

The cast-iron piles which support the arched bridge over the Medway at Rochester, England, were sunk by the means of compressed air, which kept them empty of water while workmen excavated the materials inside the piles. Each pier consists

Fig. 1021.



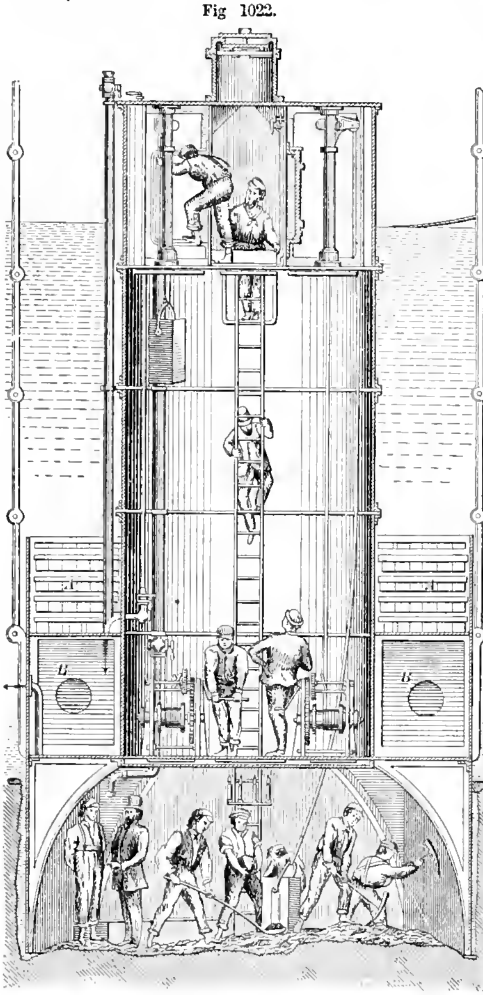
Triger's Caisson.

of fourteen cast-iron cylinders placed in a double row, and sunk through the bed of the river into the hard chalk.

This plan is the reverse of Pott's mode of sinking cylinders, in which the air is withdrawn from the interior so as to utilize the pressure of the atmosphere in forcing the pile downward, while the material, of a somewhat soft nature, ascended into the cylinder. The contents were from time to time scooped out, and the air-exhausting process repeated. This plan was adopted with a bridge which crosses the Thames near Richmond, England.

Fig. 1022 is a section of the movable iron caisson used in building the piers of a bridge at Copenhagen, Denmark. It comprises an upper chamber communicating with the air, an intermediate or air-chamber, both equal and cylindrical in section, and a lower working-chamber of larger section than the foregoing, and adapted to the shape of the pier; the whole raised or lowered by suspension-chains, and ballasted with iron and water contained in two annular chambers *A* and *B*, surrounding the lower part of the air-lock. In working, the apparatus was lowered to the bottom of the water, and an excavation made until a stratum capable of forming a solid foundation was reached; upon this a layer of concrete was laid, and then the structure completed with brick-work faced with granite; the caisson was gradually raised as this progressed, and when it was finished up to the water-line, the caisson with its

Fig 1022.



Caisson at Copenhagen.

suspending stage and tackling was removed to the site designed for another pier, where a similar operation was repeated.

Caissons of this kind, having an open bottom and provided with air-locks, act upon the principle of the diving-bell, the pressure of air in the working-chamber and air-locks being equal to that of the depth of water in which they are submerged. This renders the use of the air-lock necessary.

The piers of the Illinois and St. Louis Railway-bridge, across the Mississippi, at St. Louis, are constructed by means of an analogous device. See AIR-LOCK, opp. p. 49.

These, however, are not designed to be removable. The matter to be excavated, being principally sand, is brought up by sand-pumps with extension suction-pipes. A hose, connected with a force-pump, is employed to reduce this matter to a proper consistency. When solid rock is reached, the air-chamber, locks, and shafts are filled with concrete to the top of the pier, which has been gradually built up on the roof of the air-chamber, and around the caisson, as the sinking of the latter proceeded.

The caisson designed to find a stable surface and establish the foundation of the pier for the East River Bridge, between New York and Brooklyn, is rectangular; in length, 168 feet; width, 102 feet; interior hight, 9½ feet, with a roof 5 feet thick; the sides are 9 feet thick at the roof, sloping down to a round edge, so as to facilitate its entry into the ground. This part is of cast-iron, protected by boiler-plate; the remainder, of heavy timbers strongly bolted, braced, and specially coated to prevent leakage of air or water through the pores and joints. It is provided with air-shafts and locks, and air-supply shafts for the chambers, and also two water-chambers, into which materials excavated by the workmen are placed, and elevated by a peculiar dredge.

4. A sunk panel in a ceiling. See COFFER.

5. A chest filled with explosive material, laid in or beneath the track or expected position of an enemy.

Cake-cut′ter. A device for cutting sheets of dough into round or ornamental forms, as heart-shaped, etc.

Cake-mix′er. A device for incorporating together the ingredients of cake, etc. It consists of an exterior case containing upright stationary fingers, between which a set of downwardly projecting fingers are caused to rotate by means of an attached crank, the dough or batter being stirred between the two.

Cal′a-bas. An early light form of musket. Used in and after 1578.

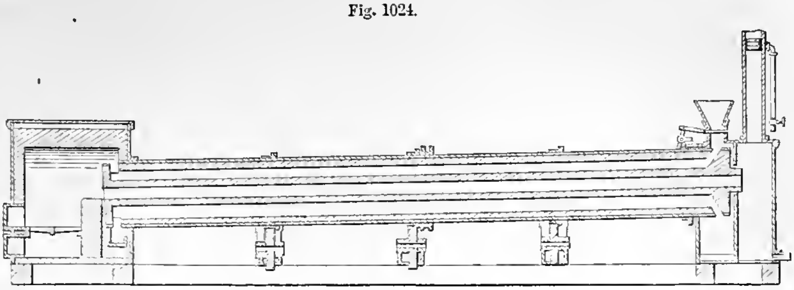
Cal′a-man′co. (*Fabric.*) A woolen stuff, checkered in the warp, so that the checks are seen on one side only. It was fashionable in the time of Addison and his compeers. The stuff had a fine gloss, and was used for ecclesiastical habits. The original goods of that name was made of camel's-hair, as the name indicates.

Cal′a-mine. A native carbonate of zinc. The original means of alloying copper with zinc, obtaining brass. This beautiful alloy was known long before the true theory of its production was understood. Calamine was known to the Greeks, Romans, and Arabians, but does not seem to have been considered as a metallic ore. It was ascertained empirically that fusing copper in contact with a certain stone gave it a yellow color, and the result — brass — was highly valued. Aristotle and Strabo refer to this earth, as do also Ambrosius, Bishop of Milan, fourth century; Primasius, Bishop of Adrumetum, in Africa, sixth century; and Isidore, Bishop of Seville, seventh century. These learned prelates mention an addition by which copper acquired a gold color. This was undoubtedly *calamine*.

Albertus Magnus, A. D. 1280, seems to have suspected the truth; but it was reserved for Paracelsus, who died in 1541, to define zinc as a metal and give it the proper standing in its group. The great Paracelsus was an empiric rather than a philosopher, but experiment has evolved the facts around which theories are spun.

Ca-lash′. (*Vehicle.*) A light carriage with very low wheels. It may be open, or covered with a folding top, which may be let down at pleasure.

Fig. 1024.



Rotary Calcining-Furnace.

Ca-lash′-top. (*Vehicle.*) A folding leather top, with bows and joints; sometimes called a *half-head.*

Cal′car. 1. (*Glass-making.*) A furnace in which glass *frit* is calcined, to effect a partial union before it is vitrified in the glass *pot.* The word is derived from the French *calquaise. Colcar.* See FRITTING-FURNACE.

2. (*Metal.*) An annealing arch or oven.

Cal′ci-na′tion. Oxidation by the application of heat and access of air.

Marble, limestone, and chalk, carbonates of lime, are deprived of their carbonic acid and water by *calcination.*

Gypsum, alum, borax, magnesia, are deprived of their water of crystallization by *calcination.*

Copper and other ores are calcined, to drive off the sulphur, the sulphurets being oxidized and sulphuric acid being disengaged and volatilized.

The *roasting* of ores is a common and analogous process. See ROASTING; DESULPHURIZING.

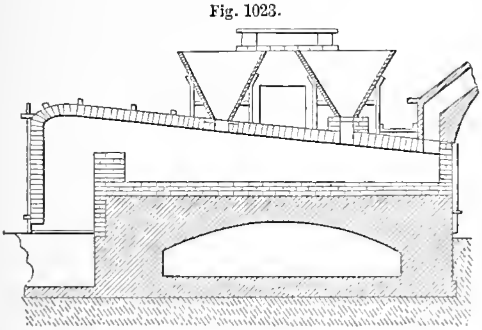
This exposure of a body to a strong heat destroys cohesion of the parts, and renders the body capable of being pulverized. In this condition metallic bodies become *calxes;* otherwise known as metallic oxides.

Cal′ci-na′tion-pot. A sort of crucible used for preparing animal charcoal.

Cal-ci′ner. The calcining or roasting furnace.

Cal-cin′ing-fur′nace. A large reverberatory furnace, having a fire at one end, two chimneys at opposite corners, four doors at which the operation is observed, the *rabbles* introduced, and the material withdrawn, and hoppers above by which the ore is introduced.

Fig. 1023.



Copper-Calcining Furnace.

The charge of copper ore, for instance, is about 3½ tons, which is dropped on to the hearth when the sliding bottoms of the hoppers are withdrawn. The hearth is 23 feet long and 23 feet wide, the vaulted ceiling descending towards the flues. The fire is built upon scoriæ, which are piled upon the grate-bars.

The effect of the roasting is to reduce the sulphurets, the sulphur uniting with oxygen and passing off in a gaseous condition. Arsenic, if present, is also sublimed and carried off. The product is in a condition for smelting.

The process with this charge of copper ore takes 11½ hours, and the calcined ores are raked out into reservoirs below the door-ways.

In another example, the cylinder is supported on rollers, and is lined with fire-brick. It is also provided with passages to contain the ore to be calcined, and to conduct the products of combustion from the furnace. The passages are grooved from end to end, and the ore is supplied to the same by means of a hopper, the supply being regulated by the feed-device; the ore escapes through into the trough, from which it is washed by a stream of water.

Other forms of calcining-furnaces are circular, horizontally-rotating tables. See REDUCING; DESULPHURIZING.

Cal′ci-um. Equivalent, 20; symbol, *Ca.*; specific gravity, 1.578; melts at 442° F. It is a light-yellow metal. The carbonate of lime occurs in nature in the forms of limestone, chalk, and marble. The oxide of calcium (lime) is an ingredient in all mortars and cements, and enters into the composition of glass and pottery.

The sulphate of lime (gypsum) occurs naturally in the form of alabaster and selenite. When ground, it forms the well-known plaster-of-paris, used for molding, statuary, and for manure.

The chloride of lime is well known as a bleaching and disinfecting agent.

Cal′ci-um-light. The Drummond or oxyhydrogen light, in which streams of oxygen and hydrogen are directed and inflamed upon a ball of lime whose incandescence gives a very vivid and brilliant light. See DRUMMOND-LIGHT.

Cal′cu-la′ting-ma-chine′. The abacus is the simplest form of calculating-machine. See ABACUS.

A number of these are considered under ARITHOMETER (which see).

Pascal, when 19 years of age (1650), invented one which forms the basis of most of the calculating-machines and registers of the present day. It consists of a train of wheels numbered 0 to 9, and gearing into each other so as respectively to represent units, tens, hundreds, etc. It is the usual registering-device of gas-meters, etc.

Babbage commenced one at the expense of the English government, in 1821, and worked upon it till 1833, when work upon it was suspended, after an outlay of £15,000. The portion completed is in the library of the King's College, London.

This renowned but unfinished machine works upon a peculiar arithmetical principle. The differences between numbers in a table are the elements out of which Mr. Babbage constructs the table itself, and on this account he called his a *Difference-Engine.* For instance, in a table of square numbers, 1, 4, 9, 16, 25, 36, etc., the difference between the first and second is 3; between the second and third, 5; and so we get a series, 3, 5, 7, 9, 11, etc. Again, this series of first differences, if viewed in a similar manner, presents us with another and remarkable series, 2, 2, 2, etc. It is found that almost all numerical tables, when thus analysed into successive orders of differences, end at last in a very simple series, constituting the materials — the atomic elements, so to speak — which, by addition, will produce all the numbers required in the table. The process of addition lies at the root of the whole method.

How to accomplish this by mechanism was the question which Mr. Babbage undertook to solve. The first term of the table and the first term of each order of differences being given, the whole table can be constructed from those elements; and dials were made to indicate these numbers. There are rows of dials to represent the successive orders of differences, and rows to represent the successive digits in a number; and by an extraordinary assemblage of mechanism, the wheels to which these dials are attached act upon each other in an order, determined by the original adjustment. Each dial has on its edges the set of digits from 0 to 9. There are axes upon which the dials revolve; teeth to the wheels behind the dials; bolts which act on or into these teeth; wedges to withdraw the bolts; and shoulders which regulate the action of the bolts on the teeth-wheels: all this determines the process of addition.

When it is understood that the skillful Dr. Lardner occupied twenty-five pages in the Edinburgh Review in partially describing the complex action of the machine, and gave up other features as hopeless without a mass of illustrative diagrams, we shall be pardoned for not occupying space by attempting farther description.

Harper's Magazine, Vol. XXX. pp. 34-39, gives some account of it, accompanied by a cut.

G. and E. Scheutz, Swedish engineers, constructed a working machine, 1837-43, after studying the Babbage machine; it was brought to England in 1854. It is stated to have been bought for £1000 for the Dudley Observatory, Albany, N. Y.

The Messrs. Scheutz have since completed one for the British government, which was subsequently employed in calculating a large volume of life-tables, which the authorities at Somerset House declare never would have been undertaken had not this machine been in existence.

Cal'cu-la'ting and Meas'ur-ing In'struments. See under the following heads: —

Abacus.
Adding-machine.
Addressing-machine.
Almucanter-staff.
Ambulator.
Angular instruments.
Arrow.
Atwood's machine.
Authometer.
Back-staff.
Balance.
Ballot-box.
Batter-level.
Bench-marks.
Bevel-square.
Boning.
Bow.
Burette.
Calculating-machine.
Caliper-rule.
Calipers.
Chain-inclinometer.
Circumferentor.
Circumventor.
Coin-assorter.
Coin-weighing machine.
Comparateur.
Conformator.
Counter.
Counter-scales.
Cross.
Cross-staff.
Danish balance.
Datum-line.
Declinator.
Delineator.
Demi-circle.
Dendrometer.
Dividers.
Dividing-engine.
Dotchin.
Dumpy-level.
Dynamometer.
Electrometer.
Electric-balance.
Fare-box.
Fare-register.
Faucet. Measuring
Fore-staff.
Funnel. Measuring
Gage.
Gaging-rod.
Garment-measurer.
Gas-meter.
Gas-register.
Geometric square.
Grading-instrument.
Graduated glass.
Grain-measurer.
Grain-scales.
Grain-tester.
Gun-pendulum.
Gunter's chain.
Gunter's scale.
Hydrostatic balance.
Hygrometric balance
Indicator.
Jacob's staff.
Label.
Letter-balance.
Level (varieties, see LEVEL).
Leveling-staff.
Libella.
Limb.
Linen-prover.
Litrameter.
Log.
Lumber-measurer.
Map-measurer.
Meter (varieties, see METER).
Metrograph.
Metronome.
Micrometer.
Miter-square.
Multiplying-machine.
Napier's bones.
Needle-instrument.
Nonius.
Numbering-machine.
Numbering-stamp.
Object-staff.
Octant.
Odometer.
Optical square.
Outkeeper.
Paging-machine.
Pedometer.
Perambulator.
Plane-table.
Planimeter.
Platform-scales.
Plotting-scale.
Plumb.
Prismatic compass.
Quadrant.
Quadrat.
Recipiangle.
Register.
Scale.
Scales.
Sea-way measurer.
Sector.
Semicircle.
Sextant.
Shuttle-scale.
Sliding-scale.
Specific-gravity apparatus.
Speed-indicator.
Sphereometer.
Spring-balance.
Square.
Stadium.
Station-pointer.
Steelyard.
Stereometer.
Surveying-cross.
Surveying-chain.
Surveying-compass.
Surveying-instruments.
Swan-pan.
Tally.
Tangent-scale.
Tape-measure.
Testing-machine.
Theodolite.
Time-table.
Tourists' indicator.
Transit.
Traverse-board.
Triangular-scale.
Tripod. Surveyor's
Tron.
T-square.
Universal square.
Vernier.
Vernier-compass.
Vernier-transit.
Volvette.
Way-wiser.
Weather-glass.
Weigh-bridge.
Weighing-machine.
Weighing-scales.

See also specific indexes under METER; SCOPE; GAGE; GRAPH; LEVEL; INDICATOR; MICROMETER; REGISTER.

Cal'cu-la'tor. A machine, in the nature of an orrery, invented by Ferguson, for exhibiting the motion of the heavenly bodies.

Cal'cu-li In'stru-ments. (*Surgical.*) These comprise instruments for removing stony concretions in the human bladder; for crushing them so as to allow them to pass through the urethra and be discharged by the natural flow of urine; for grasping and withdrawing them, and for making incisions into the bladder. See LITHONTRIPTER; LITHOLABE; LITHOTOMY FORCEPS; LITHOTOMY KNIFE; LITHOTOMY STAFF, etc.

Cal'e-bas'ser-ie. (Fr.) A Belgian method of remelting iron in a sort of cupola furnace.

Ca-leche'. A small hooded carriage on two wheels.

Cal'en-dar-clock. One which indicates, in addition to the minute and hour of the day, the day of the week and month, — sometimes the year also, with the phases of the moon, etc.

The Roman calendar is said to have been introduced by Romulus, 738 B. C., who divided the year into ten months, comprising 304 days; fifty days less than the lunar year, and 61 days less than the solar year. Its commencement, therefore, did not correspond with any fixed season. Numa Pompilius, they tell us, 713 B. C., corrected it by adding two months, and made it commence at the winter solstice. Julius Cæsar, 46 B. C., sent for Sosigenes of Alexandria, who again corrected it, making the year 365 days, 6 hours, every fourth year being leap-year. This is denominated the Julian style, and prevailed generally throughout the Roman world. Julius made the first day of the reformed year begin with the day of the new moon following the solstice, which day thus became the first of January.

The year of the change was called the year of confusion, owing to its containing 445 days. The Greeks left off their lunar months, and their intercalations of 45 days every fourth year; the Egyptians changed their *thot*, or first day of their year, which changed from one season to another; and the Hebrews did the like. It was generally adopted for a time in those portions of the three continents dominated by the Romans.

Time works changes, but changes in the modes of measuring time are resented innovations. The vernal and autumnal equinoxes, the summer and winter solstices, each formed the commencement periods for the years over large areas of country at various times. The uniformity of the Roman system was lost when they abandoned their provinces, but as the intellectual center still remained in the South the nations again gave in their adherence. By an edict of Charles IX. in 1564, the beginning of the year was ordered in France, at January the first. The change was not made in England till a much later period, and is far from invariable even now in that country.

In the time of Pope Gregory XIII., A. D. 1582, the calendar had become defective to the amount of ten entire days, the vernal equinox falling on the 11th instead of the 21st of March. This was owing to the fact that the solar year is 365 days, 5 hours, and 49 minutes nearly, instead of 365 days, 6 hours, as defined by the Julian system. To compensate for the error, Gregory ordained, by a brief issued October 5, that the current year (1582) should have only 355 days; October 5 became October 15. To obviate further irregularities, it was determined that a year beginning a century should not be bissextile, with the exception of that beginning each fourth century. Thus the years 1700 and 1800 were not bissextile, nor will 1900 be, but the year 2,000 will be a leap-year. In this manner three days are retrenched in 400 years, because the lapse of 11 minutes 10.3 seconds makes three days in about that period.

The Protestant States of Germany adopted the New Style at various times from 1700 to 1774. Great Britain adopted the New Style by act of Parliament, September, 1752; the 3d of the month being called the 14th. In one of Hogarth's pictures, "The Election," a drunken bummer holds erect a placard with the inscription, "Give us our Eleven Days." He is sitting all in a heap upon the ground, protesting against the loss of time while squandering the present. In some of the English mining-districts, the year is yet divided into 13 "mining months." Contracts are thus made, and wages paid; it has the advantage of causing the month and the week to terminate on the same day.

The Greek Church have not adopted the Gregorian innovation, as they consider it, and still use what we call O. S. (old style). The Jews have their own new year; so have the Turks; the Chinese celebrate their new year by making a dreadful din.

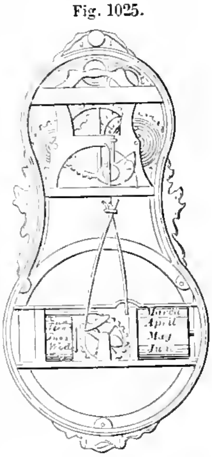
The Russians yet adhere to the Julian style, so that in writing to Russia it is necessary to date thus, for instance, $\frac{12}{24}$ March, or $\frac{25 \text{ September}}{7 \text{ October}}$, or $\frac{28 \text{ December, } 1872}{9 \text{ January, } 1873}$, as the case may be.

The English civil year, from the 14th century till the adoption of the New Style of Gregory XIII. in 1752, commenced on Lady-day, the day of the Annunciation of the B. V. M., March 25; the half-year was at Michaelmas, the Feast of St. Michael, September 29. Leases are yet drawn in England, occupation and rent being calculated with reference to these recurring festivals. The Old Style is still retained in the English Treasury, so that the Christmas dividends are not considered due till Twelfth-day, the midsummer till July 5, and so on. The usage of the commencement of the year at March 25 is still retained, so the first day of the financial year is Lady-day of the Old Style, that is, new Lady-day March 25, + the 11 days removed by act of Parliament 1752, = April 6; thus embodying both the ancient practices, namely, the commencement of the year at about the vernal equinox and the old Julian style, which had lost 11 days in 1798 years.

The Mexicans had a year of 360 days and 5 supplementary days. They divided it into 18 months of 20 days each, and had a leap-year. Their year commenced at the vernal equinox.

The Peruvian year began with the winter solstice.

Fig. 1025.



Calendar-Clock.

The Jewish civil year is 12 lunar months = 355 days. Their ecclesiastical year begins at the vernal equinox, about March 22. The civil year 5634 A. M. begins September 23, 1873, and ends September 11, 1874.

The Mohammedan year is 12 lunar months = 355 days; the year 1290 A. H. (Anno Hegiræ) commencing March 1, 1873, and ending February 17, 1874.

The Chinese new year commences at midnight on the recurrence of the new moon which falls nearest to the point when the sun is in the 15° of Aquarius; say, the nearest new moon to the 5th of February.

The first day of the new year of the French revolutionary period was September 22, 1792; their year consisted of 12 months of 30 days each, with five sacred (!) days at the end, dedicated to Virtue, Genius, Labor, Opinion, and Reward (!!). The bissextile day each fourth year was devoted to the renewal of the oath of liberty.

The appearance of the calendar-clock is familiar, the names of the days and months appearing at slits in the dial or case; or else indicated by pointers on a number or lettered dial or dials. The illustration shows one of the first-mentioned kind, in which the names of the days of the week and months of the year are inscribed on two revolving drums, and presented consecutively at slits in the front of the case, — removed, in the example, to expose the works.

Cal′en-der′ing. The series of operations, differing according to the goods, of straightening, damping, pressing, stretching, starching, drying, embossing, and watering woven goods; including the various processes intervening between the bleaching or dyeing and the packing for market.

The fabric is first passed over a water-cistern, kept constantly full, by which it is wetted, preparatory to being drawn through a pair of rollers, by which it is partially smoothed. It is also pulled out breadthwise, and the edges knocked against a smooth beating-stock.

It is now ready to go through the *mangle*, which consists of a number of rollers, adjustable to any desired pressure, so as to remove any creases which may remain. For this purpose, the bottom rollers are sometimes grooved, the grooves spreading outwardly from the center on either side. Above these are three smooth rollers, two of wood and one of brass, which equalize the surface and stretch the cloth.

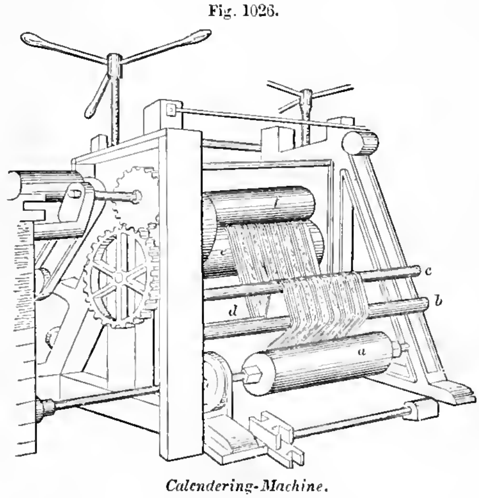
The starching is effected by drawing the cloth under a roller, which dips into a trough of flour-starch, fermented, previous to boiling, to deprive it of gluten. Superfluous starch is removed by other rollers, between which the cloth passes, and falls back into the trough.

The stuff is now dried, by passing it over heated cylinders of tinned iron or copper in the case of heavy goods, while muslins are merely stretched on frames in a warm room. What is called *patent finish* may be given it by working the two long sides of the frame backwards and forwards in opposite directions, giving the muslin a diagonal motion, which is continued until it is quite dry. This removes the harsh and stiff appearance caused by the starch.

The process of giving the glossy surface-finish distinctively known as calendering is described under CALENDERING-MACHINE.

Cal′en-der′ing-ma-chine′. Though the business of the calenderer includes all the finishing processes by which bleached or dyed cotton and linen goods are stretched, starched, glossed, and pressed, yet the *calendering-machine* proper is a machine between whose loaded rollers the cloth is passed to give it the finish and luster desired.

Fig. 1026.



Calendering-Machine.

Cloth which was formerly calendered by burnishing with a smooth flint-stone, is now glazed by passing between rollers, one of which moves slower than the other, so that a rubbing action is obtained.

The machine was introduced into England by the Huguenots about 1685, on the revocation of the Edict of Nantes. This edict was granted to the Protestants of France by Henry IV., April 13, 1598, and revoked by Louis XIV., October 22, 1685. They scattered to England, to Charleston, S. C., and other places, taking their industry and their skill with them.

The fabric is first damped by passing it slowly over the *damping* or *degging machine*, containing a circular brush, the points of which, as they rapidly revolve, just touch the surface of the water and dash a cloud of fine spray against the cloth, by which it is uniformly damped. It is then ready for calendering.

By means of a weighted lever, or by screws on top of the calendering-machine, any required amount of pressure may be applied to the fabric; a very great pressure, by flattening the threads, gives a smooth and silky surface. By passing two folds between the rollers at the same time, the threads of each mutually produce a meshed appearance on the other. A watered surface is produced by passing the goods in a very damp state through plain or indented rollers; sometimes a slight lateral motion is given it.

The rollers are heated, when required, by inserting a red-hot cylinder into them.

Cal′i-ber. 1. The bore of a fire-arm or gun, or the weight of the ball which fills it to its capacity, allowing for *windage*.

Sometimes applied to steam cylinders and pumps.

It finds three different modes of expression: —

a. The diameter in inches; as, 8-inch gun, 10-inch cylinder, etc.

b. In the weight of the solid, round shot adapted thereto; as, 8-pounder, 12-pounder gun.

c. In the hundredths of an inch expressed decimally; as, carbines and rifles of .44, .50, .55 inch caliber.

2. (*Horology.*) *a.* The plate on which the arrangement of the pieces of a clock is traced. The pattern-plate.

b. The space between two plates of a watch, which determines the flatness of the movement.

Cal′i-ber-com′pass. A form of calipers adapted to measure the sizes of bores. See CALIPERS.

Another kind is used for measuring shot and shell. See SHELL-GAGE.

Cal′i-ber-rule. A gunner's calipers; having two scales to determine the weight of a ball from its diameter, and conversely.

Cal′i-co-print′ing. A mode of impressing figured designs upon cloth; the term also including modes and processes not strictly mechanical.

Calico is printed cotton cloth. In England, such are called *prints; calico* being the plain white cotton cloth, bleached or unbleached.

The name *calico* is derived from Calicut, a seaport of Malabar, visited by Vasco de Gama in 1498, and afterwards the principal seat of the Portuguese power in India. Calico was brought from India to England in 1631.

Where the art originated, it cannot be said to be useless to inquire; for, though the positive answer may not appear, the inquiry leads in directions which will be either "fresh fields and pastures new," or to regions which we tread again with pleasure and enthusiasm.

The Chinese have used printing-blocks from time immemorial. Printing on cloth preceded printing on paper, but it cannot now be determined how long ago. The Chinese applied the art to printing on bark, leaves, skins, or scale-board.

The natives of India were far in advance of all other people, both in the variety of their styles and the excellence of their execution. They used wax as a *resist;* used *mordants* of different kinds, so as to produce different colors by boiling the cloth in a solution of one color. They also had the *bandanna* style, in which spots are left white by topical pressure on the parts, preventing the access of the dye.

Of the *resist* style, the *pallampoor* may be cited. In this, the pattern was painted in wax upon the cloth, which was then dyed. (See PALLAMPOOR.) Of the *mordant* style we have an excellent account in Pliny (d. A. D. 79) : —

"Robes and white veils are painted in Egypt in a wonderful way; they are first imbrued, not with dyes, but with dye-absorbing drugs, by which, though they seem to be unaltered, yet, when immersed for a little while in a caldron of the boiling dye-liquor, they are found to become painted. Yet, as there is only one color in the caldron, it is marvellous to see many colors imparted to the robe, in consequence of the influence of the excipient drug. Nor can the dye be washed out. A caldron, which would of itself merely confuse the colors of cloths previously dyed, is thus made to impart several colors from a single dye-stuff, *painting as it boils.*" See MORDANT.

It will be noticed that Pliny credits the Egyptians with the work; this may be true as to the goods he saw, but it is also quite likely that the goods he saw were of Hindoostanee manufacture, brought to the Mediterranean by the Arabians. It is evident that the Egyptians also practiced the art, but it was upon linen, and not cotton, the peculiar stuff which Herodotus calls *tree-wool* and rightly ascribes to India. (See COTTON.) In the latter country, the calico-printing, whether of the *resist* or *mordant* styles, was performed by hand, and was rather *painting* than *printing*, as to the mode of its execution.

Variegated linen cloths of Sidon are mentioned by Homer; and Herodotus speaks of the garments of the inhabitants of the Caucasus as variegated with figures dyed by infusions of leaves.

Cortez found the Mexicans in possession of the art, their garments of cotton being adorned with Dolly Varden figures in black, blue, red, yellow, and green.

The art was practiced in Asia Minor and the Levant long before its introduction into Europe, and even then it came in at the southwest, with the Saracens. Abderahman III. founded the cotton, silk, and leather manufactures in Spain, about A. D. 930. He also devoted great attention to the sugar-cane, rice, and the mulberry. This great Arabian people also taught Europe to make Chinese paper of pulped fiber.

It seems a pity that these gentlemen should be worsted by those gloomy tyrants, the Pedros and Philips, and that the liberality and civilization of Cordova should be superseded by the bigotry of Dominic.

About the close of the seventeenth century, Augsburg became famous for the manufacture of its printed cottons and linens. About the same time, that is, in 1696, calico-printing was introduced into England from France, by one of the French victims of the revolution of the Edict of Nantes. He established works on the Thames, near Richmond. This villainous act of Louis XIV. inured to the benefit of other nations, especially England, who gave an asylum to many industrious artificers and artists. About twenty-five years afterwards, the linen, silk, and woolen manufacturers obtained a law against the use of printed cotton goods, either imported or home-made. This was relaxed in 1730 to this extent, that goods with linen chain and cotton filling were allowed to be printed, paying an excise duty equal to twelve cents per square yard. In 1774 this restriction was removed, all cotton printed goods were allowed to be made; the duty was reduced to six cents per square yard. This was afterwards increased to seven cents, and in 1831 was abolished.

The history of the fight in France of printed calicoes against the linen and woolen manufacturers is substantially similar to that just recorded, except that the government of France resisted the mobs instead of becoming subservient to them, as in England. Thus the French passed through the ordeal of absurd sumptuary legislation, and got rid of the incubus sooner than their more conservative neighbors north of "the Channel."

"Sir Martin Noell told us the dispute between him, as farmer of the additional duty, and the East India Company, whether callico be linnen or no; which he says it is, having been ever esteemed so: they say it is made of cotton woole, and grows upon trees, not like flax and hemp. But it was carried against the Company, though they stand out against the verdict." — *Pepys's Diary*, February 27, 1664.

Coloring substances for calico-printing are divided into *substantive* and *adjective*. The former are capable of producing permanent dyes of themselves; the latter require certain intermediate matters, called *mordants.*

The commonest mordants are the acetate of iron, the acetate of alumina, and some solutions of tin.

1. *Madder* or *chintz style.*

The parts of the cloth which are to have a madder color imparted to them are printed with a mordant. After *ageing*, that is, allowing the mordant to become firmly attached to the cloth, the superfluous mordant is washed away by a warm mixture of cow-dung and water. It is then washed and *winced* in a weak solution of alum and size. It is then drawn through a colored solution, and this becomes fixed in the parts where the mordant has been applied. The cloth is washed in soap and water, bran and water, or dilute solution of chloride of lime, which removes the dye from the unmordanted portion of the cloth. It is then ready for rinsing, drying, starching, calendering, and folding.

2. *Printing by steam.*

In this process the colors printed with a mordant are fixed by steam driven through the cloth and acting upon the mordant. After drying and ageing, the thickening material is washed out, and the cloth finished in the usual manner by starching and calendering.

3. *The padding* or *plaquage style.*

By this a pattern may be produced on white or colored ground, or a ground may be formed for a design in other colors. The cloth is spread with a colored paste, dried, and then printed with another colored solution; a chemical reaction takes place where the colors are mingled, forming a pattern upon the general ground of the former color. This is the style referred to by Pliny, — "a design on a white ground is produced by printing with one solution and wincing in the other."

4. The *resist* or *reserve style.*

The white cloth is printed with a paste which resists the action of color when the cloth is placed in the vat. The cloth is then dyed in the piece, and subsequent washing removes the dye from the part protected by the *resist-paste.*

5. The *discharge* or *rongeant style.*

The dyed or mordanted cloth is printed with a discharger, which renders the color, where it is impressed, colorless or soluble, so that it may be washed out.

6. The *china-blue style.*

This is only practiced with indigo, of which several shades may be associated with white. The bleached calico is printed with a combination of indigo and other materials, aged, and immersed successively in three solutions. The effect is to cause the surface-indigo to permeate the cloth and become precipitated in an insoluble form.

7. *Decoloring* or *enlevage style.*

The dyed goods are treated with chlorine or chromic acid to discharge the colors at the required places.

8. *Spirit-color printing.*

The colors are produced by a mixture of dye extracts and solution of tin, called by the dyers *spirits of tin.*

9. The *bandanna* style, in which spots are left white by topical pressure on the parts, preventing the access of the dye.

There are several mechanical modes of printing calico: —

a. Wooden blocks prepared with a pattern on one surface and pressed down on the cloth by hand.

b. Several such blocks fixed in a frame and worked by machinery.

c. The pattern engraved on a flat copper plate, which is pressed down upon the cloth.

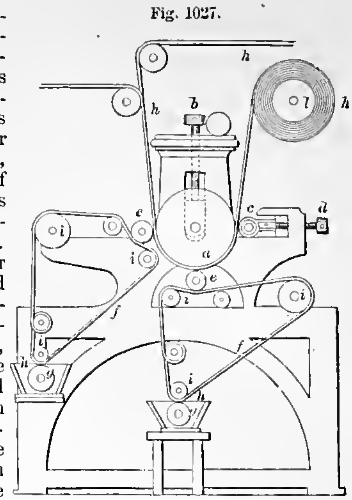
d. The pattern is engraved on a copper cylinder, over the surface of which the cloth is made to travel. By a combination of cylinders, various colors are laid on to form a various-colored print.

All the cheaper printed cottons are now printed by the cylinder process. The pattern is engraved on a roller of soft steel, about three inches long and one in diameter, called the *die*, so as to exactly occupy its external surface; this is hardened by being heated to redness and suddenly plunged in cold water. The design is then transferred by means of a rotatory press from the *die* to a similar small roller in a soft state, called the *mill*, producing an impression in relief. The *mill* is then hardened and placed in a rotary press, imprinting the pattern on the copper *cylinder* from 30 to 40 inches long and from 4 to 12 inches wide, from which the calico is printed; the impression has to be repeated a sufficient number of times to cover the face of the copper cylinder, care being taken to make the junctions of the small cylinder accurately fit each other.

For costly and delicate goods, such as shawls and velvets, the block method of printing is still adhered to. In this method, each color has a block to itself, on which a certain portion of the pattern is cut or engraved; the blocks are used singly and by hand, each printing as much as its size will permit. Where the whole design is but a repetition of one small pattern, the whole surface of the cloth is printed by a succession of applications of the same two or three blocks; but where a large shawl, for example, displays a design which is not merely a repetition of small bits of pattern, the number of blocks often becomes multiplied to an extraordinary degree. A fine barege shawl is mentioned as having required more than five hundred blocks to produce the entire pattern, every one representing a different part of the device, either in color or pattern, from any of the others. The great number of the blocks in such a case is principally due to the fineness, intricacy, and the non-repetitive character of the pattern, and not to its size, unlike the *loud* trousers pattern of Regent Street, which required that three gentlemen should walk abreast to exhibit it.

In the calico-printing machine, the pattern is engraved on cylinders of copper, which supply themselves with their respective colors during their revolutions, by means of inking-aprons *f* from the color-tubs *h*. Each cylinder is engraved with its portion of the pattern in relief, and they are so arranged that each makes its impression in the exact spot in relation to the other parts of the pattern.

Fig. 1027.



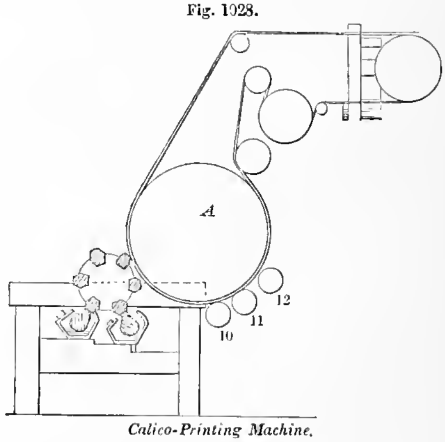
Calico-Printing Machine.

The machine illustrated is adapted for two pattern-rollers. The cloth to be printed is unwound from a roller *l*, and passes beneath the smooth roller *a*, receiving an impression from each of the rollers *c* as it passes. The roller *a* runs in journal boxes, which are regulated by a set screw *b* at each end, and a smoothing-roller *c*, actuated by a set screw *d*, holds the cloth against the roller *a*. The pattern-rollers *c c* are inked by the aprons *f f*, which pass over the rollers *i i i*, the outside surfaces of the aprons coming in contact with the surfaces of the rollers *g g*, which revolve in the ink-troughs *h h*.

After receiving the impressions from the pattern-rollers *c c*, the cloth *h* is led off to be dried and folded.

In another form of the machine, each copper cylinder is engraved with as much of the pattern as

Fig. 1028.



Calico-Printing Machine.

the printing in a particular color; the pattern being sunken in, not raised upon, the cylinder. The cylinders are arranged horizontally, and each, as it rotates, dips into a trough containing its own particular color, mixed as a thickish liquid. A long knife, called a *doctor*, then comes in contact with the surface, and scrapes off all the color, except that contained in the engraved lines of the pattern. The cloth is made to travel over rollers and beams, and to come in contact with the printing-cylinders in succession, being pressed upon each in its passage, and receiving from each an impression. The cylinders are exactly placed in reference to the pattern, and the tension and rate of the cloth is so regulated that it comes to each cylinder in exact time and place to receive each color in proper relation to each other.

Fig. 1028 shows a form of machine in which the cloth is presented serially to a set of hexagonal prisms whose facets, at each rotation of the prism-carrier, receive their color from cams which rotate in their respective color-troughs. Two of these troughs are shown, but more may be applied if desired. The motion of the prism-reel and of the color-cams is so prearranged that the salient portion of each cam advances to give color to its appropriate prism, while the others pass by uncolored. 10, 11, 12, are ordinary printing-rolls, which may be auxiliary to the prismatic colorers. *A* is the main cylinder which carries the end apron on which the cloth passes from the pay-off roller, past the printing, and thence to the dryer or ageing-loft.

Cal'i-duct. A pipe for conveying hot water or steam for heating purposes.

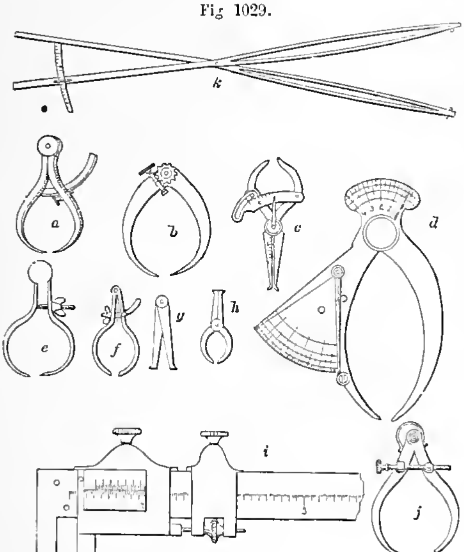
A term given by Cardinal Polignac, 1713, to the pipes, etc., in which air was heated by the adjacent fire, and from which the air passed into the room.

They were used by the ancient Romans (see HYPOCAUST), and in the Arab palaces of Cordova, in Spain, about A. D. 1000, being imbedded in the walls, and carrying the heat of the hypocaust to the apartments in winter.

Ca'lin. An alloy of lead and tin, used by the Chinese as a lining for tea canisters and boxes.

Cal'i-pers. An instrument, jointed like a pair

Fig. 1029.



Calipers.

of dividers, but with arched legs, and adapted for taking the diameter of convex or concave bodies.

It is said to have been invented by an artificer of Nuremberg in 1540. This will not do; the calipers is a mechanical thumb and finger, a device of very ancient date, and is shown on Roman tombs. See COMPASSES.

a is a *bow* calipers, with arc and tangent screw.

b, a calipers whose legs are operated by a worm-wheel and pinion.

c is an *inside and outside* calipers with a graduated arc and index-finger.

d is a calipers which shows by the index and arc at the joint the distension of the points. One leg has a spring, and expands as the calipers is passed over the work, the index on the leg showing the amount of variation from the true size to which the joints have been set.

e is a spring calipers.

f, a common form of calipers with arc.

g, inside calipers. *h*, inside and outside calipers.

i is a vernier calipers, for inside or outside measurements, which reads to thousandths of inches. On the other side are sixty-fourths or fiftieths of inches to read without a vernier. The description of the mode of using this instrument is well worth embodying here, but we cannot spare room.

j is a spring calipers with pivoted operating screw and nut.

k is a calipers for measuring standing or cut timber; it has arms about thirteen feet long, and a brass arc on which are figures denoting the quarter-girth in feet and inches.

Gunners' calipers are for measuring the bore or caliber of guns and projectiles.

A scale like a sliding-rule has different sets of numbers engraved on it, to exhibit the corresponding diameters in inches and weights in pounds.

The graduation is in accordance with the rule that with balls of the same metal the weights of the balls are as the cubes of their diameters.

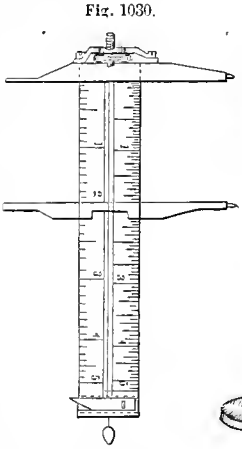
Calipers for inspecting hollow projectiles comprise:—

Those for measuring the thickness of metal at the bottom, at the sides, and at the fuse-hole reïnforce.

The first consists of a semicircular arm having a diametrical sliding index; the second, of a similar arm, pivoted, and the third of a graduated bar with a stationary and a sliding toe. See SHELL-GAGE.

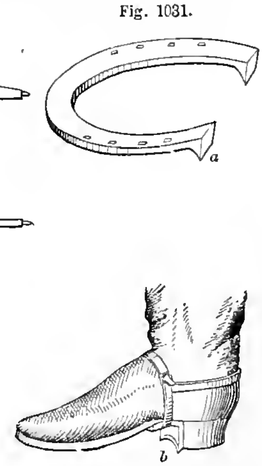
Cal'i-per-square. A square having a graduated bar and adjustable jaw or jaws. The example is a rule carrying two cross-heads, one of which is adjusted slightly by a nut, the other being movable along the rule. The cross-heads on one side are adapted to the measurement of interior diameters or sizes, and on the other side to the measurement of external sizes. See also *i*, Fig. 1029.

Fig. 1030.



Caliper-Square.

Fig. 1031.



Caiks.

Cal'i-ver. An old form of hand-gun. An *arquebus.*

Calk. A projection from a shoe or clog which digs into the ice or frozen ground to prevent slipping. The word is allied to the Anglo-Saxon word *calc*, a shoe; or the Latin *calcar*, a spur.

In a horseshoe, the calk *a* consists of a downward projection from the heel, made by turning over the iron of the heel and sharpening it.

The calk *b* attached to a boot consists of a plate with spurs, which project a little below the heel.

Calk'ing. 1. (*Shipwrighting.*) The process of filling the seams between the planks of vessels, and of spreading the ends of the *treenails*, by driving in oakum.

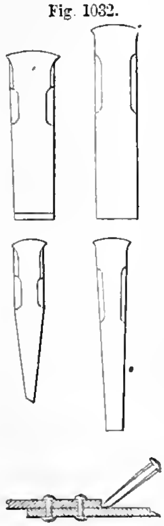
Oakum is made by cutting old ropes and cables into short lengths called *junk*, and picking that to pieces.

The seam is opened by a *reaming-iron*, driven by a *beetle*, and the threads of oakum driven in, one after another, by a *calking-iron* and *beetle*. It is farther compressed by a *making-iron*, or *horse-iron*, held by one man and driven by another. This is called *horsing-up*.

It is then *payed* with melted pitch.

The calking of plates in iron ships is performed by two men, — one holding a chisel or calking-tool, and the other striking it with a hammer, making a slight indentation along the seam. The effect of this is to force the edge of one plate hard against the other, and thus fill up any slight crevice between the plates which the rivets have failed to close. See CALKING-CHISEL.

Fig. 1032.



Calking-Chisels.

2. Tracing with a style the outlines of a print which lies on a colored-chalk paper superimposed on a white sheet of paper. By this means a chalk outline is imparted to the lower paper. It is the principle of the manifold writer. Also written *calquing.*

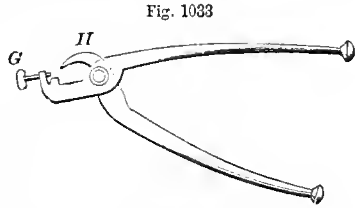
Calk'ing-an'vil. A blacksmith's anvil or hardy, adapted for the turning over, forming, and sharpening of horseshoe-calks.

Calk'ing-chis'el. Calking-chisels for closing the seams between iron plates are made of different sizes and forms. The annexed illustration is as good as a specific description. It shows chisels in side and front views, and also the operation.

Calk'ing-i'ron. A CALKING-CHISEL (which see).

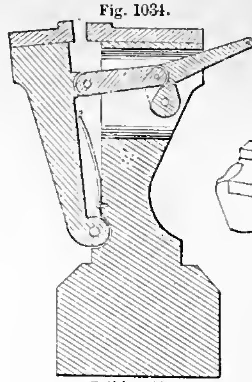
Calk'ing-tongs. An implement for sharpening the calks of horseshoes. In the example, the set screw *G* is set so that the rear of the calk may bear against it, while its lower edge is trimmed by the chisel-edged jaw *H* without detaching the shoe.

Fig. 1033

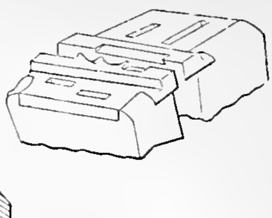


Calking-Tongs.

Fig. 1034.



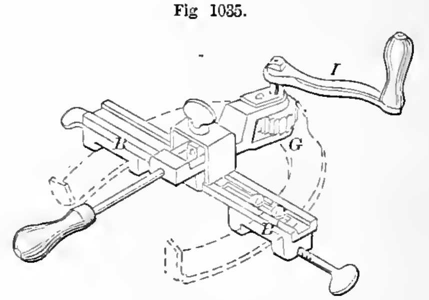
Calking-Vise.



Calk'ing-vise. An anvil with a jaw attached, acting as a vise to grasp the shoe while the calks are swaged by the hammer.

Calk-sharp'en-er. A device for sharpening horseshoe-calks. In the example, the frame *B* is clamped to the shoe by means of a screw. The rotary cutter *G* is adjustable on the frame, and is operated by a crank *I*.

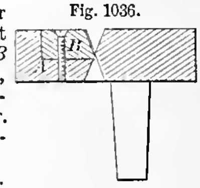
Fig 1035.



Calk-Sharpener.

Calk-swage. A swage for forming horseshoe-calks. That illustrated has the die-piece *B* inserted into a metallic block *A*, so that it may be readily removed and replaced by another. The shank sets in the hardy-hole of the anvil.

Fig. 1036.



Calk-Swage.

Call. A boatswain's whistle.

Cal-laud Bat'ter-y. A double-fluid battery, invented by Jean Armand Callaud, a French electrician; practically a modification of Daniell's.

The porous cup or partition is dispensed with, a single cell being used; the separation of the fluids being effected by their difference in specific gravity.

In the cell the copper or — element is at the bottom, while the zinc or + element is suspended in the upper half of the cell, which is then filled with a saturated solution of sulphate of zinc. Sulphate of copper, in crystals, is then gently dropped in, falling to the bottom, where it dissolves, and remains, owing to its greater specific gravity.

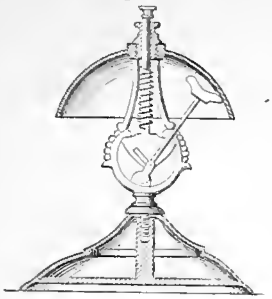
Of the Callaud battery, there are several modifications; namely, —

Hill's, in which a vertical glass-tube, open at both ends, is introduced, its lower end resting in the copper solution, its upper end extending up to the top of the cell. Its function is that of a feeding-reservoir for the copper solution, the sulphate of copper being introduced therein.

Phelps's, in which the changes are merely mechanical, giving greater surface to the elements, and suspending the zinc by a central upright arm from a three-armed support resting on top of the cell.

The Callaud battery has met with great favor, and gone into extended use on account of its simplicity, cheapness, and constancy.

Fig. 1037.



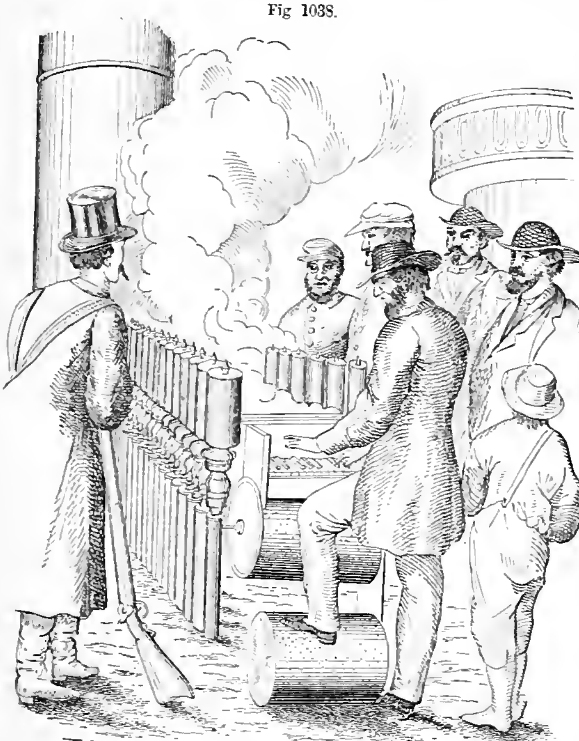
Call-Bell.

Call-bell. A small stationary hand-bell. In that illustrated a vertical plunger passes through the axis of the bell, and, by means of its slotted plate, vibrates the clapper, which is pivoted beneath. The blow is repeated as the plunger is again raised by the spiral spring.

Cal-li'o-pe. Calliope (the sweet-voiced) was, in ancient mythology, the muse who presided over epic poetry, or poetry in general.

The instrument represented in Fig. 1038 can, however, hardly lay claim to be called *sweet*-voiced. It consists of a series of steam-whistles toned to produce musical notes.

Fig 1038.



Calliope.

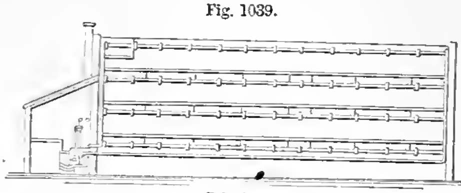
The valves by which steam is admitted to the whistles are operated by keys arranged like those of an organ.

It is sometimes placed on the upper or hurricane deck of steamboats, serving to amuse the passengers and astonish the natives on shore.

Ca-lor'ic-en'gine. A name conferred by Ericsson upon his hot-air engine. See AIR-ENGINE.

Ca-lor'i-fere. A French heating-apparatus, invented by Bonnemain, of Paris, 1777, in which an ascending current of hot water proceeds from a boiler, and, after coursing through the system of heating-pipes in the various stories and apartments, descends again to the boiler, comparatively cool.

Fig. 1039.



Calorifere.

The system has been amplified, hot-water urns being placed in the various apartments and heated by a branch-pipe from the main artery, the cooled water or water of condensation flowing to the venous system of descending pipes, which reach again the heart whence the water flowed.

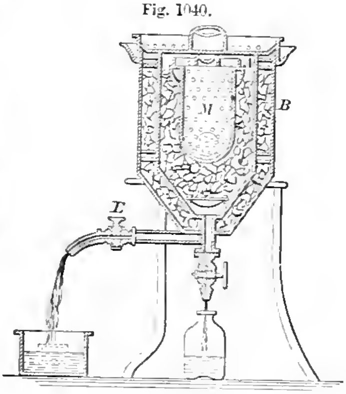
Watt warmed buildings in this manner in 1784.

Cal'o-rif'ics. In the systematic classification of mechanical subjects, those devices concerned in heating, by fire directly or by steam, hot water, or hot air in vessels or by pipes or flues.

Heating and cooking stoves, grates, ranges, and fireplaces; hot-air furnaces, flues, and ducts, their dampers, valves, regulators, and thermostats; gas stoves and cookers; cooking-utensils, and the appliances of the above. See list under STOVES AND HEATING-APPLIANCES.

Cal'o-rim'e-ter. An instrument for measuring the quantity of heat given out by bodies in passing from one temperature to another.

Fig. 1040.



Calorimeter.

In its special form, as invented by Lavoisier and Laplace, it operates by the melting of ice around the body to be tested; determining the specific heat of the body.

This method consists in heating a given weight of the body up to some fixed temperature, say 212°, then plunging it into dry ice, and subsequently determining the amount of ice which it melts in cooling down to 32°.

The body whose specific heat is to be determined, after having been weighed and heated for some time in an oil or water bath, is placed in the central compartment *M*. A lid is quickly placed over it, and covered with pounded ice, which already fills the surrounding vessel *A*. Over this another lid is placed and covered with ice, which the outer concentric vessel *B* also contains. Finally a double lid covers the whole. The vessel *M* is thin, so that the ice in *A* is quickly melted, and, flowing out by the stopcock, is collected and weighed. The ice in *B* is but little affected, and any water that may collect passes off by stopcock *E*.

The latent heat of water being known, the specific heat of the substance may be readily calculated from the quantity of water which has been melted from the ice in *A*.

Black's method was a single block of ice in which a cavity was made to contain the heated body over which an ice cover was laid. After a time the substance and cavity were wiped dry with a cloth, the weight of the water of liquefaction determined, including the moisture imbibed by the cloth.

Other modes are cited by writers on thermotics.

Ca-lor′i-mo′tor. A voltaic battery formed of a single pair of extremely large plates. The plates may be coiled around each other, and suspended over a tub of acidulated water, into which they may be lowered at pleasure.

The apparatus possesses extraordinary deflagrating power.

Ca-lotte′. (*Architecture.*) A cup-shaped elevation or small dome in the ceiling of a chamber or alcove, to increase its elevation; so called from *calotte*, a segment of a sphere.

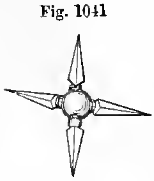
Cal′o-type. (*Photography.*) A process invented by Fox Talbot. Paper saturated with iodide of silver is exposed to light, and the latent image developed, and afterwards fixed by hyposulphite of soda.

The paper is floated on a solution of iodide of potassium, dried, floated on a solution of nitrate of silver. The effect is a film of iodide of silver, by the double decomposition of the two salts in contact. Excess of salts is washed away, and the paper dried, in the dark. The sheet, before use, is floated on a solution of gallo-nitrate of silver. After exposure in the camera the latent image is developed by nitrate of silver and saturated solution of gallic acid; then fixed by bromide of potassium and hyposulphite of soda. The result is a negative, which by a repetition of the process produces a positive.

Calqu′ing. See CALKING.

Cal′trop. (*Fortification.*) A pointed instrument to impede the progress of cavalry.

Fig. 1041



Caltrop.

It is a ball with four spikes, so arranged that, fall as it will, one is vertical and the other three stand as a tripod.

Bronze caltrops (*tribulus*) were used by the Romans.

Calx. 1. Broken and refuse glass, which is restored to the pots.

2. A metallic oxide, the result of the calcination of a metallic earth or ore.

Cal′y-on. Flint or pebble stone, used in building walls, etc.

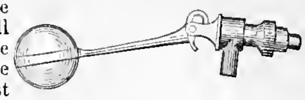
Cam. A revolving disk, usually of a spiral, eccentric, or heart shape, fixed on a shaft; or such other form as to impart to a lever, rod, or block in contact with it such velocity or alternating or variable motion as may be required. See CAM-WHEEL.

The cam for one form of expansion gear of steam-engines has a disk of cast-iron whose periphery is cut in steps so as to suit the different degrees of expansion.

Ca-ma′ieu. (*Fine Arts.*) A painting in a single color. A *monochrome*.

Cam-ball Valve. A valve actuated by a cam on the axis of a ball-lever, so that, as the float rises in the cistern, the cam shall press against the stem of the valve and close it against its seat, thus shutting off the supply when a given level has been attained in the cistern, tank, or boiler.

Fig. 1042.



Cam-Ball Valve.

Cam-bayes′. Cotton cloths made in Bengal, Madras, and other places in India.

Cam′ber. 1. A curvature upwards, as a deck amidships, a bridge, a beam, or a lintel.

It is given for —

a. Conferring stability, as in a bridge, beam, or girder.

b. Giving a water-shed, as in a deck or roof.

c. Compensating for settling or subsidence, as in the soffits of straight arches.

2. The curve of a ship's plank.

Cam′ber-beam. A beam which is laid upon the *straining-beam* in a truncated roof, and supports the lead or copper covering of the summit. It has a slope towards each end to run off the water.

Cam′ber-slip. (*Bricklaying.*) A strip of wood with one edge curved equal to a rise of one inch in six feet. Used for striking the soffit-lines of straight arches, to give them a slight rise, in order that they may settle straight.

Cam′brel. An iron with hooks on which to hang meat. See GAMBREL.

Cam′bric. (*Fabric.*) *a*. A delicate linen fabric, originally manufactured at Cambray.

It is of fine texture, white, and is checked, striped, or plain.

b. A cotton fabric in imitation of fine linen. Its varieties are, glazed, white, and colored for linings; twilled, figured, striped, and corded.

Came. A grooved bar of lead adapted to hold a pane of glass. These cames cross each other at angles, being usually diagonally disposed in lattice form in the frame of the window. The diamond-shaped panes are termed *quarrels;* the mode of glazing, *fret-work*.

Cam′el. 1. A water-tight structure placed beneath a vessel or a load, to raise it in the water, in order to assist its passage over a shoal, a bar, or to enable it to be navigated in shoal-water.

Camels were used by the ancients in floating and moving heavy obelisks and monoliths.

The camels used by the Venetians for floating large vessels over the Laguna consisted of four cases with concave sides, so made as to embrace the whole ship. They were towed under the ship, fastened together, and the water was then pumped out.

Camels are in frequent use in Holland for floating vessels over the sands and bars. The length of one of these camels is 127 feet; the breadth at one end is 22 feet, at the other 13 feet. The interior is divided by water-tight partitions.

A vessel drawing 15 feet of water could, by this means, be made to draw only 11 feet, and the largest man-of-war in the Dutch service could be made to pass the sand-bars of the Zuyder Zee. The invention, in Holland, is ascribed to Meuves Meindertszoon Bakker, of Amsterdam, about 1688.

The approaches to Amsterdam had always been obstructed by sand-bars and similar obstacles, so that vessels of heavy draft were forced to receive and deliver the greater part of their cargoes several miles below the city, which was effected by means of lighters. To enable large vessels to pass the shoals, previous to the invention of the camel, large chests filled with water were fastened to their bottoms, and the water was afterwards pumped out. This method was attended with great difficulty, but in the year 1672 it was employed to get the whole Dutch fleet to sea.

The camel of Bakker consisted of two half-ships built in such a manner that they could be applied below water on each side of the hull of a large vessel. On the deck of each were a number of windlasses from which ropes proceeded through openings in the one, and, being carried under the vessel to be raised, entered like openings in the other, and were carried to the windlasses on deck. When used, a sufficient quantity of water to sink them to the required depth was admitted into the two halves of the camel; the ropes were cast loose, and the vessel conducted between them. Large beams were passed horizontally through the port-holes, with their ends resting on the camel on each side. The ropes were made fast, the ship secured between the two parts of the camel, and the water pumped out, when they, of course, rose, bearing the ship up with them. By this apparatus, a vessel could be raised from four to six feet.

A primitive arrangement of this sort was used by Perry in 1813, by which he succeeded in getting his two largest vessels, which drew too much water to cross the bar, out of the harbor of Erie, Penn., in the face of the enemy. The guns, loaded and shotted, were whipped out, landed, and placed in battery on the shore.

A large scow was placed on each side of the vessel and filled with water; beams were passed through the ports, resting on blocking in the sunken scows, which were then pumped out, raising the vessels several feet.

The camels used by Colonel Gowen, in removing the sunken vessels which obstructed Sebastopol harbor, had a lifting-power of 5,000 tons. They were nearly submerged, and then connected by chain-falls to a vessel, through the ports or under the bottom. Being then pumped out, the vessel was raised, and floated to shallower water, when the process was repeated, and so on.

2. (*Stocking-frame.*) A bar mounted upon four wheels, and capable of being drawn forward and backward through a small space. Upon it are mounted the *jacks* with their springs, and the *slur-bar* upon which traverses the *slur* by which the jacks are actuated successively.

Cam'e-o. 1. Salient, as opposed to *intaglio.*

2. A stone or shell carved in relief.

The peculiar feature required in the material is that it shall have parallel layers of different colors. Some varieties of chalcedony fulfill this requisition, as the *agate*, which is striped and has layers of varying curvatures, and sometimes curiously contorted strata around a general center.

Another chalcedony is the *onyx*, which has parallel layers of varying colors, and is considered the choicest material for cutting cameos.

The commoner material for cameos is the conch-shell (*strombus*), a mollusk found in many parts of the world, and having two distinct layers of different colors and character. The inner layer is dark-colored, black in the finer specimens from the West Indies and South America, and pink in other specimens, which are not so highly prized, as being less like the Oriental onyx.

The *porcelanous* or inner portion is very hard and intractable to tools of steel. It is dark, and forms the basis or ground of the picture, which is cut in the *nacreous*, whiter, exterior portion, which yields readily to graving-tools.

In dividing the shell into pieces of suitable size for the purpose intended, the lapidary's slicer is used, furnished with diamond dust or some abradant of sufficiently hard grit. Whatever may be the material employed, the figure is cut in one layer upon the other layer as a basis or ground.

The piece of shell is cemented to a block, and is cut by a variety of carving-tools, rather approaching the chisel in their manner of manipulation; the cut being obliquely downwards, to avoid scaling off a layer of the nacreous shell.

The limits of this work forbid detailed artistic description. The work in relief is polished with putty-powder, applied by a tooth-brush.

Engraving in relief on monocolored gems, such as the beryl or emerald, does not fulfill the conditions of the true cameo.

Cam'e-o-in'crus-ta'tion. During the last century the Bohemian glass-makers excited surprise by producing bas-relief casts of busts and medals inclosed within a coating of white flint-glass, and an extension of this art was subsequently patented in England. The process consists in making the article to be incrusted of less fusible materials than those of which the glass by which it is incrusted is composed. A mixture of China clay and silicate of potash is found to answer this requirement. The bust or bas-relief is made of this material in a plaster mold, and after being slightly baked is gradually cooled. A mass of transparent glass is blown hollow, with one end open, and the clay cameo, heated to redness, is placed within it. The mass is pressed or welded to make the two substances adhere, and the glass-blower draws out the air from within, thus causing the glass to collapse and to firmly unite with the cameo. When the glass is cut and polished to any desired form, the effect produced is striking and beautiful; for the clay cameo or bust has the appearance of unburnished silver isolated in the midst of the solid, transparent glass. Small articles are incrusted in a more expeditious manner, especially upon glass goblets or similar hollow vessels. The hot cameo is placed upon the hot vessel, a small piece of semi-liquid glass is dropped upon it, and this both fixes the cameo in its place and forms a glassy layer to inclose it.

Cam'e-o-type. (*Photography.*) A fanciful name given to a small vignette daguerreotype for mounting in a jeweled frame like a cameo.

Cam'e-ra. The cameras used in photography are known by names which indicate construction or purpose. They are, —

Folding, so as to be portable.

Expanding; the front part is rigid and carries the lens, the after part slides on the front part, and carries the dark slide and focusing-screen.

Bellows-camera; the front and after sides connected by a flexible cover.

Copying-camera.

Solar camera; the sun's rays are transmitted through a transparent negative.

Stereoscopic camera; two cameras in one, taking two pictures on the same plate. A substitute arrangement is that in which the camera receives successive positions on one stand with two stations.

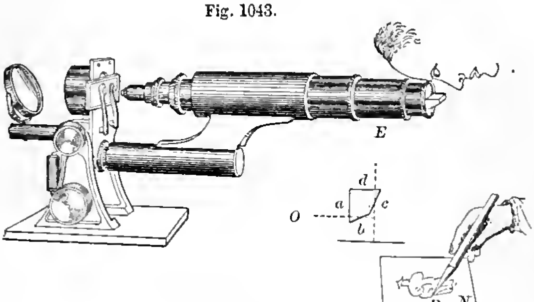
Panoramic camera, one in which a picture may be taken upon one flat, including an angle of 90° more or less. Invented by Sutton. See also PHOTOGRAPHIC CAMERA.

Cam′e-ra-lu′ci-da. Founded upon the invention of Baptista Porta (1589), by Dr. Hooke, about 1674. Improved by Wollaston, 1805. Phil. Trans., Vol. XXXVIII. p. 741.

It consists of a glass prism *a b c d*, by means of which rays of light are bent by two reflections into a path at right angles to their previous direction. A ray of light proceeding from *O* enters the face of the prism at *a*, is reflected by *b* and *c* till it assumes the direction *c E*, at which latter point is the eye of the observer.

As a contrivance of Dr. Wollaston, for the purpose of delineating a microscopic object, it consists of a prism fitted on the front of the eye-piece of the microscope *E*, in place of the *cap* by which it is usually surmounted. The rays passing through the eye-piece into the prism are reflected from its oblique surface and come to its upper horizontal surface at right angles to their former direction, and the eye receives them with a part of the pupil, while it looks beyond the prism, with the other part of the pupil, to a white paper surface *N*, on the table, and the hand follows with a pencil-point, *P*, the outlines of the object apparently projected thereon. The image and the paper occupy the same field, and the image, therefore, is apparently displayed upon the paper.

Fig. 1043.



Camera-Lucida

The optigraph is an instrument for the same purpose, but of different construction. See OPTIGRAPH.

Cam′e-ra-ob-scu′ra. The invention of this instrument has been credited to Roger Bacon, 1297, and to Alberti, 1437. It was described by Leonardo da Vinci, in 1500, as an imitation of the mechanical structure of the eye. The theory of optical sensation was laid down by Alhazen the Saracen, A. D. 1100. See BINOCULAR GLASSES.

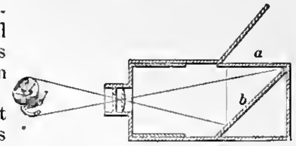
Baptista Porta, in 1589, mentions it in his book on "Natural Magic." Sir Isaac Newton remodeled it, 1700. Daguerre, in 1839, rendered the images obtained therein permanent, after Wedgewood, Davy, and Niepce had only partially succeeded. See PHOTOGRAPHY.

The camera-obscura as described by Baptista Porta is a dark chamber of cylindrical form, with a lens at one end and a white card or paper at the other, so placed as to be within the focus of the glass upon which the external image is depicted.

The instrument, for the uses of photographers, has been enlarged and improved. Achromatic and periscopic glass have been employed; facilities for adjustment in hight, angle of presentation, and for focus, and arrangements for introducing and withdrawing the slides. See PHOTOGRAPHIC CAMERA; SOLAR CAMERA, etc.

Before the photographic art had attained any celebrity, the camera was sold in the stores of opticians in a portable form, and used in taking sketches from life and from nature.

Fig. 1044.

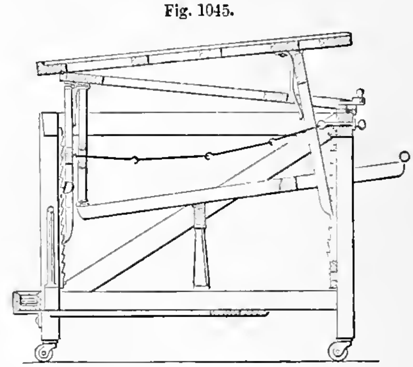


Camera-Obscura.

The beams of light enter at the lens in front of the box, and the image of the objects in the field are reflected by the mirror *b* against the under side of the ground glass *a*. The outlines of the objects are then traced on the ground glass, or on a sheet of paper sufficiently transparent for the purpose.

Cam′e-ra-stand. (*Photography.*) A frame on which the camera rests, and which is adjustable, to vary the hight, horizontal presentation, or inclination of the optic-axis as may be required. In the example, the elevation and inclination of the camera-platform are obtained by a compound arrangement of lifting-bars, ratchets, and pawls, acting within and upon a frame mounted on casters.

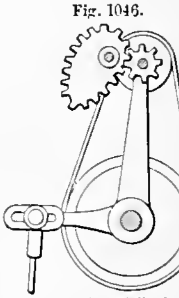
Fig. 1045.



Camera-Stand.

Cam-gear Wheel. An arrangement of gearing.

Fig. 1046.



Cam-Gear Wheel.

1. The motion of the cam-shaped cog-wheel being continuous, and the rotation of its axis in uniform times, the speed imparted to the pinion is variable, and the respective axes alternately approach and recede as the cogged cam revolves.

2. The motion being derived from the pinion by the band from the drum, the meshing of the pinion with the cogged cam will give a variable vibrating movement to the bell-crank and to the rod connected thereto.

Ca′mi-on. A heavy dray for the transportation of ordnance.

Cam′let. (*Fabric.*) A cloak-stuff formerly made of camel's hair, alone or mixed with silk; since made of wool and silk or wool and flax. It was a fashionable cloak stuff in the days of our fathers and their fathers. It was rigid from close weaving, and nearly waterproof. It went out when india-rubber fabrics came in.

Camel's-hair cloth is used for tent coverings in Algiers by the Kabyles and Berbers; in China for carpets; in Turkey for soldiers' coverlets; in Circassia for dreadnaught cloaks. Fine or coarse, its uses are great and various. Marco Polo refers to this manufacture at the city of Kalaka, in the province of Tangut, in the domain of the great Genghis Khan.

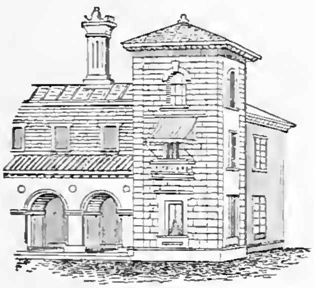
"After dinner, I put on my new camelott suit; the best I ever wore in my life, the suit costing me above £24" (*Pepys's Diary*, 1665). This was a rich silk.

"This night my new camelott riding coate to my colored cloth suit came home" (PEPYS, 1662). This latter was possibly not "my gray cloth suit and faced white coate, made out of one of my wife's petty-coates."

Ca-mou'flet. (*Fortification.*) A small mine or countermine charge intended to blow in the side of a gallery.

Cam'pa-ni'le. (*Architecture.*) A bell-tower, principally used for church purposes, but now sometimes for domestic edifices in the Italian style.

Fig. 1047.



Campanile.

Camp-bed. A bedstead for the use of military men or travelers; they are variously constructed, the object being lightness and economy of space for facility of transportation, and are usually made of iron. A *cot.*

Camp-ceil'ing. (*Architecture.*) One in which the marginal portion is sloping, following the line of the rafters, while the mid-portion is level.

Camp-chair. A form of folding chair adapted to be carried by a pedestrian, or packed away in an ambulance or wagon when on the march. See FOLDING-CHAIR.

Camp-kit. A box, with its contents, for containing soldiers' cooking and mess utensils, such as the camp-kettle, plates, etc.

Camp-mill. A mill adapted for the use of an army, to grind grain on the march or in camp. It is carried on a wagon or running-gears, and is sometimes driven by the wheels in traveling; sometimes by a sweep operated by horses or men after the wheels are anchored or sunk in the ground.

The first portable mill thus adapted to its own carriage appears to have been invented by Pompeo Targone, engineer to the Marquis Ambrose Spinola, about the end of the sixteenth century. See GRINDING-MILL; HAND-MILL.

Camp-ta'ble. One adapted to fold into a small space for transportation.

Camp-sheet'ing. (*Hydraulic Engineering.*) A piling erected at the foot of an embankment to prevent the out-thrust, or the washing by the current or waves.

It consists of guide-piles exteriorly, against which are placed wale-pieces, which are horizontal timbers. Within these are driven vertical planks of the nature of pile-sheeting.

Camp-stool. A chair whose frame folds up into a small compass for convenience of packing or carriage. Camp-stools were known in ancient Egypt, and were constructed in a manner similar to ours. They frequently occur in the paintings, and some have been preserved till our time. One found at Sakkarah is in the Abbott Collection, New York. See CHAIR; FOLDING-CHAIR.

Camp-stove. A light sheet-iron stove, specially arranged with a view to portability, and adapted for heating a tent or hut, and for cooking purposes.

Camp-tu'li-con. (*Fabric.*) A compound used as a substitute for carpet or oil-cloth.

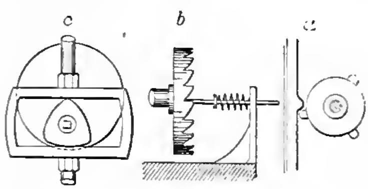
It is made by a combination of powdered cork and the poorer qualities of india-rubber, and is painted or ornamented on the surface like oil-cloth. It is not suitable for chambers, as being a good conductor of heat, and feeling as cold to the bare feet as wood or oil-cloth. A convenient application of this substance is for cleaning knives, and is made by covering a strip of wood with it; then sprinkling the surface with the cleaning powder, and rubbing on the knife. The surface does not wear away, and the result is very satisfactory.

Cam-shaft. A shaft having *cams* or *wipers*, for raising the pestles of stamping-mills. A *tumbling-shaft*, or *wallower*. See CAM-WHEEL.

Cam-wheel. A wheel with a projection (or projections) either on the periphery or face, adapted to give motion to another object against which it impinges by sliding contact. The *wiper*-wheel is an example (which see).

In the illustration, *a* represents the cam-wheel as lifting a stamp-rod or beetle; in *b* the duty of the cam-wheel is to give an intermittent, reciprocating motion to the bar, which is returned by a spring after each impulse. Their forms and applications are very various, and the actions of the heart-wheel and eccentric are substantially similar. The *heart* is a cam with a regular motion, so as to produce a back and forward reciprocation in equal times without any sharp percussive action; differing in this respect from the action of the two preceding and from that of the tilt-hammer. See HEART-WHEEL.

Fig. 1048

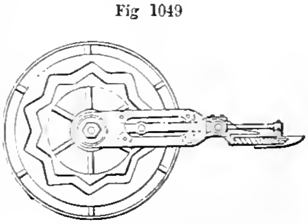


Cam-Wheels.

c is a cam and yoke in use in France for the valve motion of steam-engines. It is used for giving an intermittent, rectilinear reciprocating motion. The circular disk carries the cam; the valve has a momentary rest and then a rapid motion, a single stroke and return for each revolution of the disk.

Fig. 1049 is an illustration of a cam-wheel having a waving slot *through* the wheel, in which traverses a roller on a bar, which communicates a reciprocating motion to the cutter-bar of a harvester.

Fig 1049

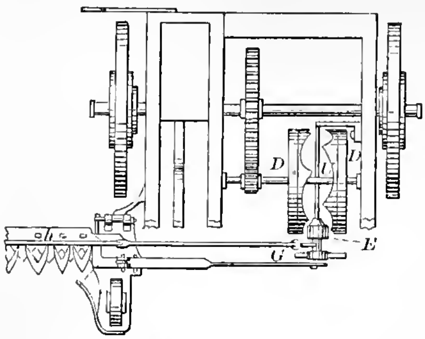


Cam Harvester-Wheel.

In Fig. 1050,

the cams are on the *faces* of the wheels *D D*, consisting of a double series of inclined curves, between

Fig. 1050.

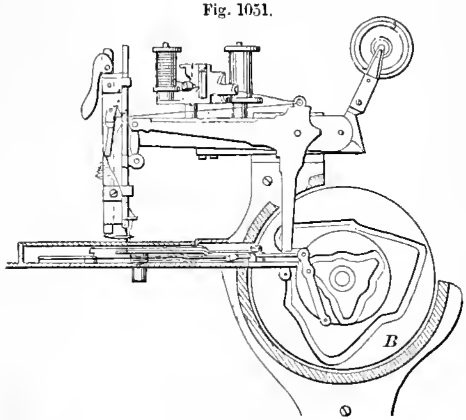


Double Cam-Wheel.

which is the race *U* of the roller *E*, whose oscillation in its track gives the reciprocation to the rod *G* on the end of the cutter-bar.

Fig. 1051 shows a disk *B* having irregular face-grooves, by which are actuated the bell-crank levers

Fig. 1051.



Irregular Cam-Wheel.

of the needle-carrier and feed-bar of a sewing-machine.

Can. 1. A sheet-metal vessel for containing liquids, etc. Cans are commonly cylindrical, but for some purposes are made square or of conical form, and provided with a handle and spout, as oil-cans for lubricating purposes.

2. The tin cylinder which receives a sliver from the carding-machine. It revolves upon a center eccentric to the center of motion of the delivering surfaces, thereby causing the sliver to arrange itself in a series of coils throughout the area of the can; as the can is filled, it rises against a plate at the top, and as the operation proceeds is pressed down and condensed.

Cans derive their names sometimes from peculiarity of construction or material, but more usually from their purpose or intended contents; such as —

Caustic alkali.	Oil.
Fruit.	Oyster.
Gunpowder.	Paint.
Milk.	Preserve, etc.

Ca-nal'. An artificial channel filled with water, and designed for navigation.

The term is also sometimes applied to narrow straits or inlets of the ocean.

Egypt and Assyria bear the palm of priority in canals. Their immense plains were early irrigated by water from the rivers Nile, Euphrates, and Tigris. The main arteries of their network of water-courses became the avenues for the transportation of produce.

The great canal which united the Nile to the Red Sea was dug by the orders of Sesostris (1500 B. C.) according to Strabo, Pliny, and Aristotle; so that China is fairly anticipated for once, as the Great Canal of China was not made till the ninth century A. D., about the time of Charlemagne.

The Egyptian canal commenced about twelve miles above the modern town of Belbays, the *Bubastis Agria* of the Romans. It was about 96 miles long, and was on the point of being abandoned several times, as it was feared that the fresh water of the Nile would be ruined by the salt water of the Red Sea, which has several feet greater elevation than the usual level of the river. The difficulty was avoided by some hydraulic contrivance, according to Diodorus Siculus and Strabo. The word is translated SLUICE (which see). It was probably an inclined chute.

The canal built by Sesostris was reopened by Pharaoh Necho about 605 B. C., by Ptolemy Philadelphus about 300 B. C., by the Cæsars, by the Caliphs; and was abandoned when Vasco de Gama circumnavigated the Cape of Good Hope.

The canal which conducted the water of the Nile to Lake Mœris during half the year, and distributed it during the other half for the purpose of irrigation, was a stupendous work, and, according to Savary, was forty leagues in length. Two additional canals were also provided with sluices, which governed the influx and efflux. Diodorus Siculus also describes the canal. His measurements differ from the modern ones.

Herodotus states that the Lake Mœris was excavated 1385 B. C., and was 450 miles in circumference. It was probably a natural basin artificially adapted as a reservoir to be filled during high Nile.

Nebuchadnezzar constructed a canal 400 or 500 miles long, running from Hit, the Is of Herodotus, to the Bay of Graine, on the Persian Gulf. It is referred to by Strabo (XVI. 1052). It has been traced by Colonel Rawlinson from Hit almost to the Bay of Graine.

Herodotus and Pliny mention the canals of Asia Minor. The first constructed in Europe was probably that dug by Xerxes across the low Isthmus of Athos. The Greeks attempted to cut one across the Isthmus of Corinth.

Among the early European canals may be mentioned the canal through the Pontine Marshes, made 162 B. C.; and the Fossa Phillistina and Carbonania, dug by the Etruscans, and which derived their water from the Padus, now the Po.

Caius Marius, 51 B. C., constructed the Fossa Marina between Arles and Fos, a haven on the Mediterranean.

Lucius Verus undertook to unite the Saone and Moselle, and also to unite the Mediterranean and the German Ocean by means of the Rhone, Saone, Moselle, and Rhine. His death prevented the execution of the project.

The great object of the Romans was to increase the facility of transportation, the great economical agent of civilization. Their land and water ways were the arteries and veins of commerce, and the ligatures which bound the provinces to the metropolis and the state.

The Rhine had in early Roman times but two outlets; Virgil calls it *bicornis*, and Tacitus says that the largest of these branches, that nearest to Gaul, is called *Vahalum*. In the days of Charlemagne the Rhine communicated with the Escaut by a branch of the Meuse which has since disappeared. A great inundation, A. D. 860, obliterated many minor channels near the efflux, and opened new ones. In the thirteenth century the Zuyder Zee was converted from an inland fresh-water lake into a gulf of the sea by a storm which destroyed the barrier between it and the latter. The Roman legions under Drusus, B. C. 12, dug a canal between the Rhine and the small river Sala, as a military defence; this became enlarged into a third branch of the Rhine; it is mentioned by Pliny. A fourth branch, the Leck, was created subsequently, in a similar manner, during an insurrection under Claudius Civilis.

When the Roman Empire fell to pieces, all engineering enterprises ceased, and the completed works fell into decay. Charlemagne revived the project of uniting the Rhine and the Danube, so as to connect the German Ocean and the Black Sea.

The first canal in England was the Caerdike, cut by the Romans.

Canals were constructed in China before the Christian era. No mention is made of canals in the Bible. The largest hydraulic works therein mentioned are those of Solomon, who introduced abundant water for baths, gardens, and fish-ponds, — aqueducts, not canals.

The largest canal in the world is the Imperial Canal of China, which extends southward from Pekin and unites the Pei-ho with the Yang-tse-Kiang. A part of the canal was constructed in the seventh century, and a part in the ninth, A. D. It is 825 miles long, and with its connected rivers gives an inland navigation of 2,000 miles, and connects 41 cities. Authorities differ as to whether the Chinese canals overcome grades by locks or inclined planes. It is to be presumed they have both.

From the twelfth to the fifteenth centuries canals in the Netherlands were made in great numbers.

The ship-canal, 51 miles in length, whereby the commerce of Amsterdam reaches the ocean, is wide and deep enough to float two passing frigates. It was built 1819–25, at a cost of $4,250,000. A still deeper and wider one is now in progress.

Previous to the invention of canal-locks by the brothers Domenico, sluices were employed in Italy. These were boarded conduits, forming chutes down which the vessel slid or floated; a gate at the upper end being lifted for the entrance of the vessel, and restored again to form a dam to preserve the upper level.

Movable gates to restrain the water on the higher level and admit the passage of boats were introduced in the navigation of the Tesino and Adda to Milan.

Cresy dates the invention of canal-locks to 1188, when Pitentino restored the Mincio to its ancient channel to the Po, from whence it had been diverted by the Romans in the time of Quintus Curtius Hostilius.

The canal of Languedoc, which unites the Garonne with the Mediterranean, passes across the narrow portion of France north of the Pyrenees, and is 150 miles in length. It unites the Atlantic and Mediterranean, and was constructed by Andreossy, an Italian engineer, in the reign of Louis XIV. The fall from the summit at Naurouse to Cette, on the Mediterranean, is 621 feet 6 inches. The fall from the summit to the Garonne is 198 feet. There are 74 locks on the eastern portion, 26 locks on the Atlantic section, which ends at Toulouse, on the Garonne; 100 locks in all.

The surface of the canal is 64 feet broad; the bottom, 34 feet; the depth, 6 feet 4 inches. The canal-boats are 80 feet long, 18 feet broad, draw 5 feet 4 inches of water, and carry 100 tons.

The canal cost $6,000,000.

The canal of Charolais unites the Loire and Saone, which, at one place, approach within eighteen leagues of each other, and fall into the Bay of Biscay and the Mediterranean respectively. The project was agitated as early as 1555, and various surveys and reports were made, as well as several commencements attempted. The lavish expenditure upon the buildings and parks for the personal aggrandizement of Louis XIV. delayed the works of public utility, and it was not till near the end of the last century that it was opened. Its length is 114.322 metres.

The canal uniting the Somme and the Scheldt was undertaken in 1776 and completed in 1810. The length is 32½ miles.

The canal of Orleans is 45 miles long, uniting the Loire and the Seine.

The canal between the Baltic and North Seas at Kiel was opened 1785. That from the Cattegat to the Baltic, 1794–1800. The main line of the Ganges Canal, 525 miles long, for irrigating the country between the Ganges and the Jumna, was opened in 1854. When completed, it will be 900 miles long, and will irrigate 1,470,000 acres. Its estimated cost is £1,555,548. Sir Proby Cautley, engineer.

The canal in England joining the Trent and the Witham was made A. D. 1134, in the reign of Henry I. The Bridgewater Canal commenced in 1759. In England there are 2,800 miles of canals.

Of the American canals: —

The James River and Kanawha, 147 miles long, overcomes the greatest grade, having a lift of 1,916 feet.

The Morris and Essex, 101 miles long, overcomes a grade of 1,674 feet, accomplished by 29 locks and 22 inclined planes.

The Erie, by DeWitt Clinton, is the longest, 363 miles, with 84 locks.

The Erie Canal was commenced in 1817, and completed in 1825. The main line leading from Albany, on the Hudson, to Buffalo, on Lake Erie, measures 363 miles in length, and cost about $7,200,000. The Champlain, Oswego, Chemung, Cayuga, and Crooked Lake Canals, and some others, join the main line, and, including these branch canals, it measures 543 miles in length, and cost upwards of $11,500,000. This canal was originally 40 feet in breadth at the water-line, 28 feet at the bottom, and 4 feet in depth. Its dimensions proved too small for the extensive trade which it had to support, and the depth of water was increased to 7 feet, and the extreme breadth of the canal to 60 feet. There are 84 locks on the main line. These locks, originally 90 feet in length and 15 in breadth, and with an average lift of 8 feet 2 inches, have since been much enlarged. The total rise and fall is 692 feet. The tow-path is elevated 4 feet above the level of the water, and is 10 feet in breadth. At Lockport the canal descends 60 feet by means of 5 locks excavated in solid rock, and afterwards proceeds on a uniform level for a distance of 63 miles to Genesee River, over which it is carried on an aqueduct having 9 arches of 50 feet span each. Eight and a half miles from this point it passes over the Cayuga marsh, on an embankment 2 miles in length, and in some places 70 feet in hight. At Syracuse, the "long level" commences, which extends for a distance of 69½ miles to Frankfort, without an intervening lock. After leaving Frankfort, the canal crosses the river Mohawk, first by an aqueduct 748 feet in length, supported on 16 piers, elevated 25 feet above the surface of the river, and afterwards by another aqueduct 1,188 feet in length, and emerges into the Hudson at Albany.

The widest are the Cornwall, Beauharnois, and Lachine (Canada), being respectively 12, 11, and 8½ miles long, and 150, 190, and 120 feet wide. Each has a depth of 10 feet, and locks 200 feet long, respectively 55, 45, and 55 feet wide. The most costly per mile is the Lachine (Canada), 8½ miles long, cost $2,000,000 ; $235,934 per mile. The Chesapeake and Delaware cost $203,703 per mile. The cheapest per mile is the Ohio and Erie, 307 miles long, $15,300 per mile. The greatest number of locks are on the Schuylkill Canal, 108 miles long, 120 locks.

The Welland (Canada), 36 miles long, admits vessels of a tonnage of 500 tons. The locks have double the capacity of any other. Cost, $7,000,000.

The Suez Canal connects the Mediterranean and the Red Sea, thus uniting the Atlantic and Indian Oceans, and saving the immense *détour* around the continent of Africa formerly necessary to reach the Indies from any portion of Europe. The length of the canal is about 90 miles, having a depth of from 20 to 26 feet, and a width of from 180 to 300 feet, sufficient to accommodate vessels passing each other on the transit from ocean to ocean. The total cost of this canal, with the necessary docks, etc., was about $100,000,000.

In the making of the Suez Canal, the total amount of earth removed amounted to about four hundred million cubic yards. By working day and night, the machines of M. Borel and Lavelley were able to remove 78,056 to 108,000 cubic metres per month.

After ten years of labor this great work was completed. Upon the 17th of November, 1869, the opening of the canal was inaugurated in the presence of the Empress Eugenie and the Emperor of Austria, and of princes, ambassadors, and men of science from Europe and America.

The transit between the two seas was safely made by the fleet. But the requisite depth had not been attained. Seventeen and a half feet of draft could be carried through the canal. Since then the depth has been increased to twenty-two feet, and ultimately will be twenty-six feet.

The length of the canal is 100 miles. The established surface-width is about 328 feet, except in difficult cuttings, where it is 190 feet. The least bottom width is 72 feet. The highest ground cut through is at El Guisr, where it is 85 feet ; at Serapeum it is 62 feet ; and at Chalouf, near Suez, it is 56 feet.

The excavation of the canal, although of considerable difficulty, was exceeded by the necessity for creating artificial harbors at the extremities. The harbor at Port Said, upon the Mediterranean, has the general form of a triangle, the base resting on the shore and the longer side on the west, protecting the entrance from the moving sand. The longer arm or mole is 8,200 feet, extending to the 26-feet curve of sounding. It is proposed to extend this mole 2,300 feet farther. As this harbor is exposed to northeast winds, an inside basin has been constructed. The area of the outer harbor is equal to 400 acres, and will permit twenty line-of-battle ships to swing freely at anchor.

At the other extremity of the canal, a mole 2,550 feet in length protects the channel, which has been dredged to the depth of 27 feet. The mole at Suez differs from that at Port Said in construction ; the latter being formed of concrete blocks of 13 cubic feet, the former of stone quarried from the neighboring mountain.

The following is a summary of the expenditures up to the date of the opening of the canal : —

General expenditures for preliminary surveys from 1854 to 1859	$15,825,525
General expenses of administration and negotiations between France and Egypt	3,394,245
Sanitary service, 1866–1869	121,410
Telegraph service	34,000
Transport service, boats, stock, buildings	1,644,435
Payment of contractors for material	3,442,785
Dredging-machines and heavy plant	6,819,240
Workshops	844,150
Works of construction, canal, and ports	43,534,330
Miscellaneous	1,392,495
Expenses of various branches of company management	3,841,050
	$80,893,665

The average cost of the canal per mile is $808,936

This magnificent work is a better scheme than the proposition of another Frenchman ; to dig a canal from the Bay of Acre to the water-shed of the Jordan, and across the water-shed between the Dead Sea and the Gulf of Akabah, thus uniting the Mediterranean with the Red Sea.

The depression of the valley of the Jordan is a long narrow basin, 200 miles in length and about 20 in breadth. About one fourth is now covered with water. It includes the Dead Sea and the Lake of Tiberias, which are 60 miles apart, and the river Jordan, by which they are connected. The depth of the ordinary surface of the water in the Dead Sea is 1,388 feet below the Mediterranean water-level, and the depth of water in the deepest part of the Dead Sea is 1,350 feet ; showing the total depth of this great depression to be 2,738 feet below the Mediterranean level. The land adjacent to the sea, however, is a table-land 3,000 feet above the Mediterranean, so that the whole depth of this great natural gorge is about 6,000 feet. The gorge is continued through the Red Sea into the Indian Ocean, but a ridge 113 feet above the Red Sea separates the waters of the Gulf of Akabah from those of the Salt Lake. The fissure, with the exception stated, may thus be said to extend from Mount Hermon to Akabah, 350 miles, and thence to the Straits of Babelmandeb, 1,200 miles farther.

The water of the Red Sea has a few feet elevation above that of the Mediterranean, which would make a water-fall of 1,400 feet depth if the water-shed at the north end of the Gulf of Akabah were to be cut through, allowing the gorge to fill with the waters of the south.

This would add about 1,400 feet depth of water to the Dead Sea, and would put the lower end of the Jordan that far under water. The city of Tiberius would be submerged 600 feet below the surface of the salt water, and the waters would ramify among the hills of Judea and the affluents of the Jordan till they found themselves checked by the mountains of "the land of Zebulon and the land of Naphtali, beyond Jordan, Galilee of the Gentiles." The sites of Capernaum and Bethsaida would thus experience a part of the fate of Sodom, submergence in salt water, while the Dead Sea would be somewhat freshened.

Aqueducts with cast-iron beds, supported by arches and piers, were introduced by Telford, 1793–

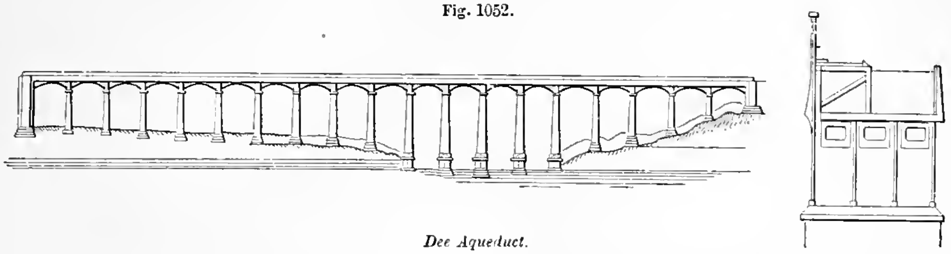
1829, in the construction of several canals; the Shrewsbury, and the Ellesmere and Chester, for instance. The aqueduct over the Ceirog is 710 feet in length, and the water surface 70 feet above the level of the river; ten arches have each 40 feet span. The breadth of the top is 22 feet; breadth of water, 11 feet; depth, 5 feet.

The stone piers are 33 feet in depth and 13 in thickness; the spandrels have longitudinal walls, supporting the cast-iron plates which form the bottom of the canal. The plates have flanges on their edges, and are united by means of nuts and screws.

The sides of the canal are built of cut-stone upon the cast-iron bed; they are 5½ feet thick on each side, and the stone is backed with hard-burned brick laid in cement. The sides have iron railings. It was completed in 1801, and cost about $100,000.

Another aqueduct on the same canal, the Ellesmere and Chester, at Pont-y-Cysyllte, is 1,007 feet long, and the water-level is 127 feet above the waters of the Dee. It has 2 abutments and 18 piers. The piers are founded on sandstone rock, are 12 × 20 feet at the bottom, and 7½ × 13 feet at the top. For 70 feet of their hight they are solid, and the remaining 50 hollow, the walls being 2 feet in thickness, with one inner cross-wall. The width of the water-way is 11 feet 10 inches, of which the towing-path covers 4 feet 8 inches, leaving 7 feet 2 inches

Fig. 1052.



Dee Aqueduct.

for the boat. The towing-path stands upon iron pillars, and the water flows beneath it.

The embankment cost about	$42,000
Masonry	105,000
Iron-work	85,000
	$232,500

In this aqueduct, the sides, as well as the bottom, are made of cast-iron. The arches have a span of 45 feet, and a rise above the springing, 7 feet 6 inches.

Canals are classed as: —

Level or *ditch* canals; consisting of one reach, level throughout.

Lateral canals; which connect places in the same valley, the fall being in one direction only.

Summit canals; in which the work crosses one or more summits, at which provision of water must be supplied.

Canals are now projected: —

To turn Lake Michigan into the Mississippi. This is under way.

Across the Isthmus of Corinth. This, as has been remarked, was projected 600 B. C. It attracted the attention, also, of Demetrius Poliorketes, Julius Cæsar, Caligula, and Herodes Atticus; but it was reserved for Nero to take the first active step toward the accomplishment of this end. He completed a canal for a distance of 3,683 feet on the Corinthian, and 6,946 feet on the Savonian, side of the isthmus.

This important historical fact has been lately ascertained through the investigations of Mons. Grimaud de Caux. The entire width of the isthmus at that point amounts to about 18,799 feet, so that it would seem the canal was more than half cut through. A canal across the Isthmus of Corinth would shorten the route from Trieste to Athens forty-one hours for sailing-vessels, and fifteen hours for steamers; from Marseilles to Athens fourteen hours for sailing-vessels and five hours for steamers; and, finally, from Gibraltar to Athens six hours for the former and two and a half for the latter.

A large ship-canal to connect the Baltic and North Seas. There are now two small ones across the Isthmus of Holstein, — the Streckenitz Canal, 1390 – 98, between the Elbe and the Trave; and the Schleswick Holstein, or Eyder Canal, 1777 – 84, between Kiel, on the Baltic, and Rendsburg, on the Eyder.

Ca-nal'-boat. A large boat, generally decked, and towed by horses; they vary in capacity, according to the width and depth of the canal on which they are employed. The usual capacity of those on the Chesapeake and Ohio Canal, one of the widest and deepest in the United States, is 110 to 115 tons of coal.

Rankine states that the heaviest boat one horse can draw at a speed of from 2 to 2½ miles per hour weighs with its cargo 105 tons, is about 70 feet long, 12 feet broad, and draws 4½ feet of water.

A boat to be drawn by one horse at the rate of 3½ to 4 miles per hour will be about 70 feet long, 6 or 7 broad, and draw about 2½ feet of water.

Ca-nal'-bridge. A bridge adapted to form a viaduct above the water-way. Movable canal-bridges may be of one of the following kinds: —

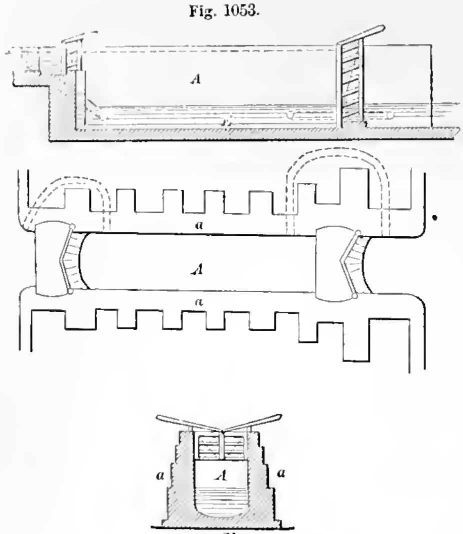
1. Turning horizontally. See SWING-BRIDGE; PIVOT-BRIDGE.
2. Turning vertically. See BASCULE-BRIDGE.
3. Rolling horizontally and in the direction of its length; one form of *drawbridge*.
4. Lifting vertically. See LIFT-BRIDGE.
5. Floating in the canal and withdrawn into a dock to allow masted boats or vessels to pass. See FLOATING-BRIDGE.

Ca-nal'-lift. A contrivance for conveying a canal-boat from one level to another without the use of water in the usual lock. It may be of the nature of the slip or marine railway, such as used on the Morris and Essex Canal, N. J., or it may be a mechanical lift by means of tackle. In one case it is proposed to float the vessel in a caisson which is supported in level position on a wedge-shaped frame which traverses on the ways.

Ca-nal'-lock. An inclosure with gates at each end, forming a connection between the upper and lower levels of a canal.

In the accompanying drawings, *A* is the *lock-chamber*; *a a*, the side walls; *E* the floor, or *invert*. The size of the chamber is a little longer than the longest boat required to occupy it; its breadth say 1 foot wider than the said boat; its depth 1½ more

Fig. 1053.



Canal-Lock (Longitudinal Section).

than the draft of a loaded boat plus the lift, and, say, 2 feet added for the coping.

The floor is level with the bottom of the lower reach, and is recessed, for the opening of the *tail-gates.* The *head-bay* has *side walls* having *gate-chambers* to receive the *head-gates.* The floor is level with the upper *pond.*

The sides of the tail-bay end in curved wings, and the *floor* or *apron* is pitched with dry stone.

At the head of the *lock-chamber* is the lift-wall, above which are the *head-gates,* whose lower edges press against the *head miter-sill.*

The *tail-gates,* which close against the *tail miter-sill.*

The culverts through the side walls shown in dotted lines are for filling or emptying the lock-chamber. These sluices are governed by slide-valves.

The cylindrical recesses in the side walls in which the gates are hinged are called *hollow quoins.*

Each gate is composed of a *heel-post, miter-post, balance-bar, cross-pieces, cleading,* and *diagonal bracing.*

There was a lock at London Bridge in Pepys's time, 1661; at least, he calls it such. It was probably a sluice, and the chatty fellow "was fain to stand upon one of the piers about the bridge, before the men could drag their boat through the lock."

Ca-nal′-lock Gate. The hinged doors at each end of a canal-lock, which are opened and closed to admit the passage of vessels. Of these there are two at each end of the lock. They are hung on pintles in the stone-work, and open outwardly, being turned by levers, similar to the tiller of a rudder, and when closed the two edges must fit as accurately together as possible to prevent the passage of water.

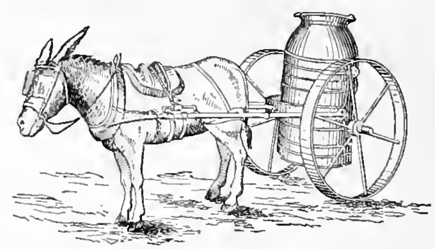
At least one gate at each end must be provided with a sluice or flood-gate near its bottom. When a boat is to pass from a higher to a lower level in the canal, the gates at the lower end are closed, and water admitted into the lock at the other end until the water in the lock is at the same hight as that of the canal above; the upper gates are then opened, and the boat admitted into the lock, when these gates and their sluice are closed. The water is then drawn from the lock by the sluice in the gate at the lower end, and when the water in the lock is at the hight of the lower level, the lower gates are opened, and the boat allowed to pass out.

To elevate the boat from a lower to a higher level, the water in the lock is brought to the lower level by opening the sluice at that end, if necessary, the gates being then opened and the boat passed in, these gates are again closed, and water admitted by the upper sluice until a sufficient hight is attained, when the upper gates are opened and the boat passed out of the lock.

Can-buoy. (*Nautical.*) A conical buoy. See BUOY.

Can-cart. A lightly framed two-wheeled vehicle supporting a large can for containing milk, etc.

Fig. 1054.



Can-Cart.

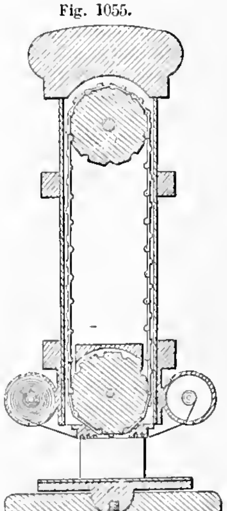
The illustration gives a clear idea of the arrangement.

Can′cel. A leaf to be cut out and replaced by a corrected page.

Can′cel-li. Among the Romans, iron gratings and trellis-work; in modern buildings, latticed windows made with cross-bars of wood, iron, lead, etc.

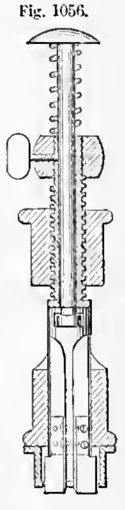
Can′cel-ing-press. A press having a plunger which defaces a printed stamp. These presses are

Fig. 1055.



Canceling-Stamp.

Fig. 1056.



Canceling-Press.

usually worked by a blow or by a lever. In some, the face of the stamp is cancelled by printing upon it the date of cancellation, as in the example (Fig.

1055, in which a socket in the lower end of the plunger has a type-chase, which may have movable type to indicate month and year inside the motto of the chase, which may be the title, etc., of the firm. A central slot in the face of the chase is occupied by one link of an endless chain, whose consecutive links have type corresponding to the days of the month, and moved in the required succession by sprocket-wheels in the plunger.

In other forms of canceling-stamps the plunger is armed with blades or points, which penetrate and tear the paper of the printed stamp, so that it may not be restorable by a process which would discharge the ink of cancellation.

Such an one is represented in Fig. 1056, which is operated by percussion of the plunger or rotation of the screw.

Can'cel-ing-stamp. A press for defacing printed stamps, to prevent their re-use. See CANCELING-PRESS.

Can'de-la'brum. A lamp-stand. Its tripedal form among the ancients is believed to have been derived from the shape of its predecessors,—braziers or basins for holding fuel, mounted on tripods.

Among the Greeks and Romans they were highly ornamental, and made of bronze and marble. They survived until lately in the branched sticks for the candles whereby halls and stately dinner-tables were illuminated.

"Euphorion, in his 'Historic Commentaries,' says that the young Dionysius, the tyrant of Sicily, dedicated, in the Prytaneum of Tarentum, a candlestick capable of containing as great a number of candles as there are days in the year." — ATHENÆUS, in the "Deipnosophists."

Can'di-teer'. (*Fortification.*) A protection for miners, consisting of brushwood, etc.

Can'dle. A cylinder of tallow, wax, paraffine, stearine, spermaceti, or other fatty material, in the axis of which is a woody wick consisting of parallel, woven, or twisted fibres, or a rush.

We may presume that the earliest forms of portable artificial lights were brands and torches, to which succeeded cressets and lamps. An elevated fire in a brazier or cresset, fed at intervals with inflammable material, such as wood and fatty or oily matters, would be an effective light for Eastern habitations, where the courts are open to the sky. We use its substantial equivalent at camp-meetings. It must be remembered that the uses of artificial light for reading and study are comparatively modern; the universal lighting up of every house as soon as darkness covers the land is a modern necessity and a modern invention. The long winter evenings of previous generations were spent by the light of the fire, not of lamps or candles, so far as the bulk of the people of all lands was concerned. But a very small number could read, and books were so scarce that kings gave security when they borrowed them; Bibles were chained in churches; and there was one law for the man who could read, and another for him who could not, the former being entitled to "benefit of clergy." In reviewing the mode of life of kings 500 years since, in comparatively barbarous England, we find one of the royal Plantagenets sitting on a stool whose three legs were driven into the dirt forming the floor of his bedchamber on the second floor, over the arched ceiling of the common hall below. His queen sits on the foot of the bedstead, and as evening draws on they find themselves sleepy after a heavy supper of beef and beer. As the drowsy king has sworn himself hoarse in recounting to his satellites the hunting adventures of the day, and has no scholastic resources, being unable to read and having no books, he finds time heavy on his hands.

While meditating on the question of whether it is worth while to kick off his boots before going to bed, he is interrupted by a chamberlain, who sleeps above, and has no way of ascending except by coming through the royal apartment. As times were not then what they once were, when the folks scattered themselves promiscuously over the floor of the hall, and people were becoming effeminate, the king bids his architect to contrive some mode by which his bedroom shall not be made a passage-way for the garreteers. To the disgust of the said chamberlain, "o' rainy nights," the builder makes an outside staircase like a ladder, and his lordship in attendance may go up, and in at the window.

Such people had but little use for a candle; they rose early, ate heartily, and slept, and no doubt snored heavily.

Scholars are scattered all along the pathway of history; but as for kings, their councilors, and the common people, they were like Scott's hero, William of Deloraine, the "stark, moss-trooping Scot," who, whatever other faults he might have had, was guiltless of violating a lady's correspondence.

> "And safer by none may thy errand be done,
> Letter or line know I never a one."

If, as Byron says, "Marmion is exactly what William of Deloraine would have been had he been able to read and write," the plentiful lack of learning was in his favor, as one had better remain a mere cattle-thief than become worse.

Lamps were known in all the ancient countries where civilization had dawned. In China, India, Egypt and Etruria, they have been so long used that the memory of man runneth not to the contrary. Comparatively modern Greece and Rome gathered them from the nations whence they derived their civilization, their mechanic arts, their conveniences, and all but their fine arts. In this latter respect, while they still retained much of the conventional, they burst the absurd fetters with which the priests had crippled the artists of Egypt. The sensuous and scoffing Greek, though a mannerist in his own way, would naturally prefer a warm model to a stone Pasht. See LAMP.

Some nations have been fortunate in the possession of bitumen, or mineral pitch, so termed, and have used it for lighting purposes from time immemorial. This has been the case especially with the Asiatic nations in the vicinity of the Caspian Sea.

Splinters of wood saturated in rock-oil, olive-oil, or animal grease, may be considered as incipient candles; and the likeness became still more apparent when a frayed piece of soft bark or a twisted lock of natural fiber, such as that of cotton or the asclepias, was dipped in melted bitumen, pitch, or an animal grease that is hard at ordinary temperatures.

The candle (*candela*) was used by the Romans before the invention of lamps (*lucernæ*). Roman candles had wicks of rush (*scirpus*), and were made of wax (*cerea*) or tallow (*sebacea*).

Alfred the Great used a graduated wax candle as a time-keeper, and placed it in a lantern to equalize its consumption by preventing flaring.

Splinters of wood saturated with animal fat were used in England by the poor, A. D. 1300. The pith of swamp-rush (*Juncus effusus*) was subsequently used for a wick, and answered the purpose tolerably, though it conducted the grease slowly, gave a very moderate light, and was easily extinguished by drafts. It is still used there, and is called a rush-light.

Diogenes (330 B. C.), who searched in daylight with a lantern for an honest man, was anticipated by three hundred years in the prophecy of Zephaniah, wherein it is declared that Jerusalem shall be searched with candles, and the men that are settled on their lees shall be punished. The candles so frequently referred to in Scripture, generally in metaphor, were no doubt cores of twisted fibers dipped in pitch, wax, or tallow. The candlesticks in their sacred buildings were very rich and ornate, and became a regular charge for a division of the priests. It is probable light was continually maintained, as in the Magian, Egyptian, and Grecian temples.

Candles are of several varieties : —

1. *Paraffine ;* obtained from the distillation of coal at a low heat, also from lignite, peat, and wood. Frequently combined in candles with sperm and stearine. See PARAFFINE.

2. *Spermaceti.* Usually of wax and spermaceti. These are molded.

3. *Composition.* Mixtures of spermaceti, tallow, with a little resin or wax, in various proportions.

4. *Stearine.* In June, 1825, Gay Lussac obtained a patent in England for candles made of the *stearic acid* of tallow, lard, or cocoanut oil.

The fatty acids are separated from the glycerine by caustic lime, the fat, lime, and water being boiled and stirred together until the mixture is fully saponified. The lime is then saturated by agitation with dilute sulphuric acid, which forms a solid sulphate of lime, and sets the fatty acids at liberty ; the latter rise to the surface, and are decanted from the limy sediment. The traces of lime are removed by washing in dilute sulphuric acid and then in clear water. The oleic acid is removed by placing the mass in bags and subjecting it to heat and pressure in a hydraulic press. The solid stearic and margaric acids are farther pressed, purified, washed while in a heated condition, decanted, and run into molds.

5. *Tallow.* These are molded or dipped.

6. *Palm-oil.* This is obtained by bruising and boiling from the fruit of the oil-palm (*Elais guineensis*). It contains about 66 per cent of a solid white fat known as *palmitine.* The oil is bleached, compressed in woolen bags. The solid matter is melted, decanted, a little wax added, and run into the molds in the frames.

7. *Wax* candles are not easily molded, and are therefore prepared by pouring wax on suspended wicks ; the cylindrical form being afterwards given by rolling hot between a wooden slab and a wet table.

Larger wax candles are made by rolling a wick into a sheet of wax, in a spiral of gradually increasing diameter. Such were those of *Drury-lane redivivus,* —

> "Tis sweet to view from half past five till six
> Our long wax candles with short cotton wicks."

Wax tapers are made by drawing a string at a regulated speed through a pan of melted wax.

The Reformation greatly decreased the consumption of wax candles and the keeping of bees. In the Castle of Wittenberg and its church 35,750 pounds of wax lights were burned yearly. In the beginning of the fourteenth century, wax and tallow candles were uncommon. Philip the Bald, Duke of Burgundy about 1361, offered to St. Antony of Vienne, for the restoration of the health of his sick son, as much wax as the latter weighed, and was held to have made a princely offer. In January, 1779, 14,000 wax candles were lighted at once in the celebration of a feast in the Electoral Palace of Dresden.

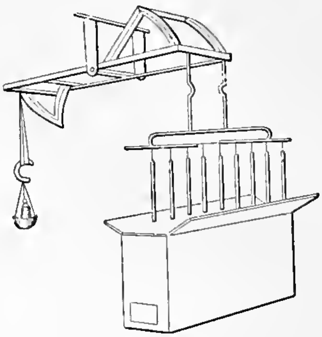
Candles which require no snuffing have slender wires twisted in with the cotton of the wick. When burning, the top of the wick turns outward in such a way as to enable the oxygen of the air to consume the charred substance, which it cannot do when in the middle of the flame.

Night-lights are short thick candles with small, thin wicks.

Machines are used for making candles with an inner core of soft or inferior material, such as tallow, and a coating of hard or superior substance, such as paraffine.

Can'dle-dip'ping Ma-chine'. A frame by which a large number of dependent wicks are dipped into a cistern of melted tallow and then lifted out of it, the process being repeated until a sufficient thickness of tallow has accumulated on the wick. The candle-dipper shown is intended to give a determinate weight to any number of candles. The wicks are suspended on rods from one end of the balance-bar, and a weight is placed in the scale at the other end. The wicks are repeatedly dipped into the tallow-vat until they acquire the desired weight.

Fig. 1057.



Dipping-Machine.

Can'dle-mold. The Sieur Le Brez of Paris is said to have been the inventor of molding candles.

The Marquis of Worcester in his "Century of Inventions," 1655, speaks of brass candle-molds in which a man may make 500 dozen in a day. He adds an ingredient to whiten, cheapen, and render the candle more lasting.

At the present day, candle-molds are usually made of pewter or tin ; in some cases glass has been employed. They may be inserted in a wooden frame, the upper part of which serves as a trough ; or several molds may be permanently attached to a tin trough, the whole constituting a single mold. Each mold consists of a cylindrical tube having a conical tip, with a circular aperture through which the doubled wick is drawn, by means of a hooked wire, allowing the loop to project a little beyond the open end of the mold ; while the other end of the wick projects beyond and closes the aperture in the conical tip. Sticks or wires are passed through the loops, their ends resting on the edges of the mold-frame. The mold is placed open end up, and the melted tallow poured into the trough by means of a ladle. When sufficiently hard, they are withdrawn by means of the wires or sticks passing through the loops.

Can'dle-stick. A well-known domestic utensil employed for holding and carrying a lighted candle, now to a great extent superseded by the introduction of gas, kerosene, etc.

The candlesticks of the ancients were very ornate, and those belonging to the temple worship were large and many-branched. The candlestick of the Hebrew Tabernacle was in the first apartment ; a constantly burning light was a feature in the worship of most Eastern nations. A candlestick or lamp-stand was emblematical of the priest's office, and was used, in metaphor at least, as an emblem of acceptable oblation ; as in Revelation, where rejection is intimated by the threat, "I will come unto thee quickly, and will remove thy candlestick out of his place, unless thou repent."

Candlesticks are mentioned in England in the reign of Edgar, A. D. 957.

Can'droy. A machine used to prepare cotton cloths for printing, spreading out the fabric as it is rolled around the lapping-roller.

Can'dy. From the Sanskrit, *kanda.* Sugar is from Sanskrit, *'sarkara.* See SUGAR.

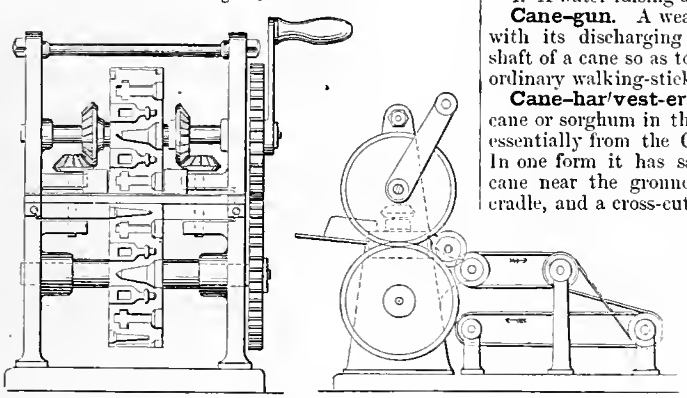
A preparation of sugar or molasses, either alone or in combination with other substances, to flavor, color, or give it the desired consistency.

Sugar-candy, as known to the British confectioner, and known as rock-candy in the United States, consists of large crystals of sugar clarified with a lesser quantity of charcoal-powder than usual, and not filtered, and the crystals aggregated on strings suspended in the vessel in which it is evaporated, and then left to cool.

Candies of various kinds, colors, flavors, and shapes, are made by different combinations of ingredients, processes, and machines, which cannot be considered at length in this work. See "The Art of Confectionary," Tilton & Co., Boston, 1866; Jarrin's "Italian Confectioner," London, 1861.

In one form of candy-making machine, the candy

Fig. 1058.



Candy-Making Machine

in its plastic condition passes between geared rolls in which are dies or molds, and having a slight space between their outer faces; side-rolls are also employed for giving uniform speed; and the molded figures pass out on endless bands driven in opposite directions, both sides of the figures being thus set or chilled.

Cane. 1. The stem of a plant of the genus *Calamus*, very common in the South of Asia along the margins of rivers and lagoons. It is split into ribbons, and used for making chair seats and backs. Machines are adapted for splitting, planing, and polishing rattan for the various purposes to which it is adapted. After the removal of strips having the polished cuticle, the core or central portion is rounded and used for basket-making and other purposes. See RATTAN.

2. The sugar-cane (*Saccharum officinarum*). See SUGAR.

3. A walking-stick.

In the manufacture of canes great quantities and varieties of materials are consumed. The blackthorn and crab, cherry-tree and furze-bush, sapling oak and Spanish reed (*Arundo donax*), are the favorites. Then come supple-jacks and pimentoes from the West Indies, rattans and palms from Java, white and black bamboos from Singapore, and stems of the bambusa — the gigantic grass of the tropics — from Borneo. These are cut at certain seasons, freed from various appendages, assorted into sizes, and seasoned. Many different processes are required to finish even the cheapest cane. The bark is to be removed after boiling the stick in water, or to be polished after roasting it in ashes; excrescences are to be manipulated into points of beauty; handles straightened and shanks shaped; forms twisted and heads rasped; tops carved or mounted, surfaces charred and scraped, shanks smoothed or varnished, and bottoms shaped and ferruled. Malacca canes have frequently to be colored in parts, so that stained and natural surfaces are not distinguishable; ivory for handles is turned or carved into shape; horns and hoofs for handles are baked, to retain their forms; tortoise-shell raspings are conglomerated by pressure into ornamental shapes, and lithographic transfers are extensively used upon walking-sticks for the Parisian market.

The Egyptian gentleman did not consider himself "fixed" without a walking-cane. He affected a certain little horn or prong near the handle-end. The lotus-flower was a favorite knob. Their canes varied from $3\frac{1}{2}$ to 6 feet long. Their names were inscribed on them in hieroglyphics.

4. A water-raising device. See HYDRAULIC CANE.

Cane-gun. A weapon comprising a gun-barrel with its discharging devices, arranged within the shaft of a cane so as to present the appearance of an ordinary walking-stick.

Cane-har'vest-er. A machine for cutting sugar-cane or sorghum in the field. It differs but little essentially from the CORN-HARVESTER (which see). In one form it has saws or blades which cut the cane near the ground, the cane falls over into a cradle, and a cross-cut saw cuts off the top, whose imperfectly matured sap injures the quality of the sugar by its feculence, and its quantity of uncrystallizable sugar.

Cane-juice Bleach'er. An apparatus for decolorizing cane-juice by means of sulphurous acid vapor. As the cane is crushed, the juice from the rollers passes by a trough into a cylinder, in which is a revolving agitator consisting of a perforated cylinder with paddle-wheels. At one side of the cylinder, and communicating with it, is a tank with a perforated cover, on which a stream of water is projected. The tank communicates with an oven containing sulphur, the vapor of which escapes into the tank, where it is purified by the water, and then passes into the cylinder, where it is mingled with the cane-juice by means of the agitator.

Cane-knife. A knife like a sword or Spanish *machete*, used for cutting standing cane. It has a blade from 18 to 24 inches long, and is made in various patterns for the Southern or South American market.

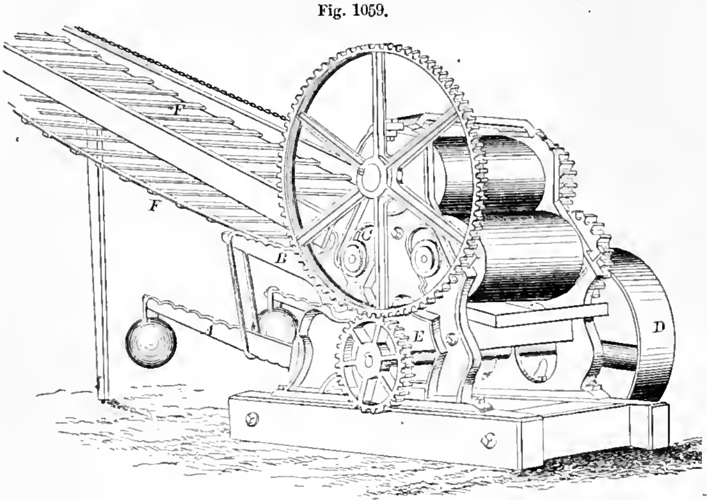
The necessities of the sorghum culture in the United States have given rise to several special tools, among which are the strippers. (See CANE-STRIPPER.) These are for the purpose of removing the blades from the stalk, the former being green, immature, and absorbent, tending to depreciate the quantity and quality of the juice, which is feculent enough at any time.

The cane must be topped also, for the same reason; the saccharine juices of the top are crude and immature, and the panicle is not calculated for the purpose, its duty being to elaborate starch, which is somewhat matured at the season of cutting.

Cane-mill. A machine for grinding sugar-cane or sorghum-stalks.

By a system of levers *A* and *B* the roll *C* is forced up against the top roll in close contact with it, so as

Fig. 1059.

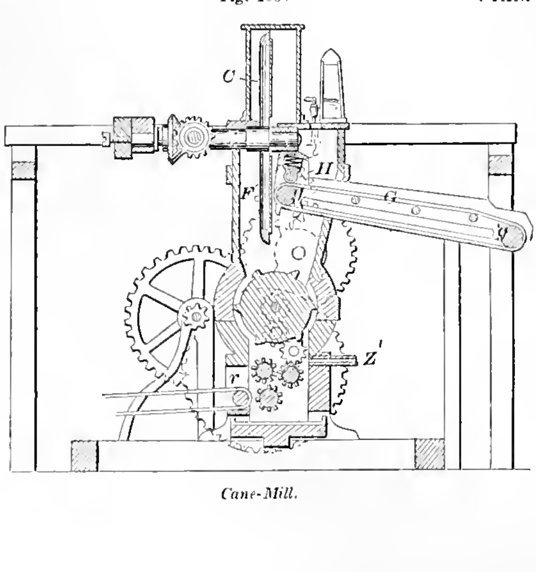


Sugar-Cane Mill.

to mash large and small canes. The strain is regulated by the shifting of the weights on the compound levers, so as to produce any pressure required. The power is applied to the pulley *D*, and transmitted to the upper roll through the pinion *E*. The endless apron *F* carries the cane to be crushed.

In Fig. 1060, the cane is fed into the mill by an endless belt *G*, and is held by the rollers *H g*, while the revolving knives *C F* chop it into pieces, which fall on the crushing-wheel beneath. This wheel grates the pieces against the concave and reduces them to a pulp, which then drops on the expressing-rollers, where it is subjected to a jet of steam, which is emitted by the nozzle *Z'*, and the bagasse eventually carried out by the endless apron *r*.

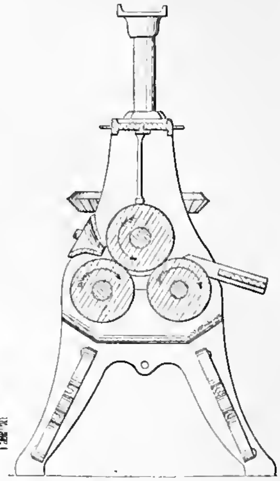
Fig. 1060



Cane-Mill.

Fig. 1061 shows a sorghum-mill on a somewhat smaller scale, having three rolls which give two points of pressure. The cane is fed by a narrowing spout between the rolls *J K*, and then between *J L*. The juice is received in a pan, the rolls are kept clean by a scraper, and the bagasse delivered on to a discharge-board.

Fig. 1061.



Sugar-Cane Mill.

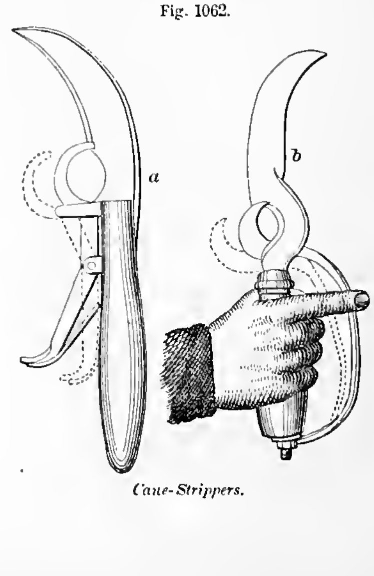
Cane-pol'ish-ing Ma-chine'. A machine for polishing the hard siliceous cuticle of rattan-splints after they are split and rived from the cane. See RATTAN; CANE-WORKING MACHINE.

Cane-press. Bessemer's cane-press has a plunger reciprocating in a trunk into which the cane is introduced transversely. A length of cane is cut off at each stroke of the plunger, and then jammed against the mass of cut cane, which is eventually driven out at the open end.

Cane-scrap'er. A machine for cutting away the woody fiber from the back of a splint of rattan, to bring it to a thin, pliable strand or braid, for weaving into a chair-seat or for similar use. See RATTAN.

Cane-split'ter. One for cutting and riving splints from *rattan*. See CANE-WORKING MACHINE; RATTAN.

Fig. 1062.



Cane-Strippers.

Cane-strip'per. A knife for stripping and topping cane-stalks.

The cane-knife and stripper *a* has a spring jaw, which coincides with an indentation in the blade, to form a circular opening. This, being clasped upon the stalk, is drawn rapidly downward, stripping off the leaves, and the blade is ready for topping when needed.

The cane may be stripped while standing in the field, which some prefer.

The cane-knife and stripper *b* has a spring jaw, which is arranged like the curved guard on a sword-hilt. The dotted lines show the position assumed by the spring jaw when opened to be placed over a stalk.

Other forms of cane-strippers are tubes armed with knives, which strip the leaves from the stalk which passes through the tube.

Cane-work'ing Ma-chine'. Machines for splitting the *strands, splints,* or *braids* of rattan from the central portion of the cane. The part used is the polished bark, and the machines for working it are known as *cane splitters, planers, scrapers, shavers, dressers, reducers, polishers.* Some of these names are synonymous.

Splitters make longitudinal incisions through the bark at such distances apart as may suit the circumference of the cane and the desired width of the strand. The cane is forced through an opening, which has radial knives which divide the strands, and tangential chisels which lift the strands and part it from the central core, a cone spreading the strands outward clear of the core. The next operation is to plane, pare, or shave the inner or woody side of the strand, so as to make that side quite smooth and bring the strand to an even thickness. The machine has adjustable knives and gages.

The reduced splints are then polished by passing beneath rapidly rotating wheels.

Can-frame. A cotton-roving machine in which the roving is received into *cans.* A *can-roving frame.*

Can'gan. (*Fabric.*) Chinese coarse cotton cloth. It is in pieces 6 yards long, 19 inches wide, and has a fixed currency value.

Can-hook. A device for slinging casks in hoisting. The ends of a piece of rope are reeved through the eyes of two flat hooks and stopped. The tackle is hooked to the middle of the bight.

Fig. 1063.

Can-Hook.

Can'is-ter-shot. Spherical iron shot, smaller than grape, and used with guns of all calibers up to 10 inches. They are laid in tiers in a tin case or canister somewhat smaller in diameter than the bore of the gun, having an iron plate at the top and bottom. The interstices between the shot are filled in with sawdust closely packed, and, when full, the iron cover is put down, and the end of the canister, which is cut into slips for the purpose, is turned down over it. Different-sized shot are provided for each description of cannon, those for howitzers being smaller than those for guns of the same caliber. Of the former, 48 shots are packed in the canister, and of the latter, 27. Canisters are employed against masses of troops at short ranges; at distances greater than about 400 yards, case-shot are considered more efficient. Canisters for the 12-pounder mountain-howitzer are always, and those for the smaller rifled guns generally, filled with musket-bullets.

Can-knife. A domestic implement for cutting open the lids of tin cans. See CAN-OPENER.

Can'ne-quin. (*Fabric.*) White cotton cloth from the East Indies.

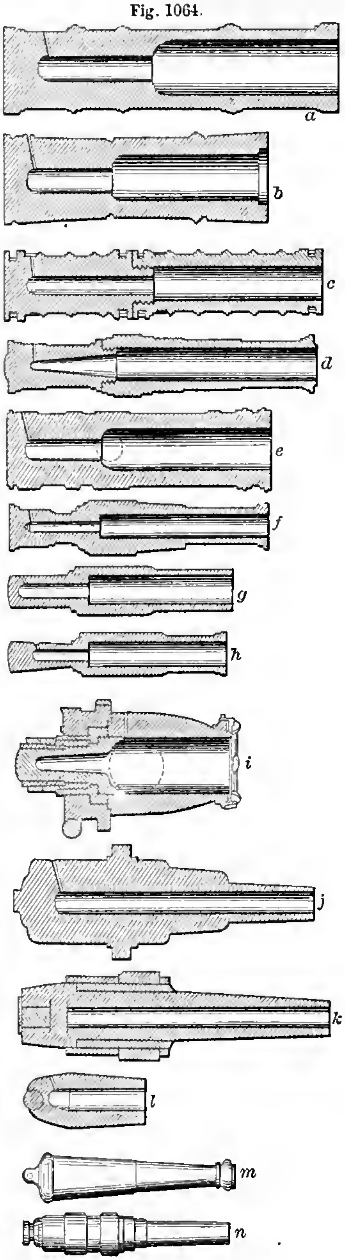
Can'non. 1. A fire-arm of a size which requires it to be mounted for firing. As synonymous with *ordnance* or *artillery,* it includes great guns, howitzers, and mortars; the latter are pieces of relatively short bore and large caliber, for firing shells. Howitzers are short pieces with sub-caliber chambers, and are, in some respects, a grade between guns and mortars.

The name is derived from the same root as *canne* (Fr.), a reed; and the English words *can, cane, canal, canoe,* etc., which, with the German *kanne,* Latin *canna,* and Greek Κάννα, are presumably derivatives from some Sanscrit root signifying a tubular or hollow object. See HOWITZER; MORTAR.

The earliest cannon was doubtless Chinese, for thence came gunpowder. The history of cannon is the history of GUNPOWDER and of FIRE-WORKS (see under those heads). The nitrous efflorescence of the Tartar plains combined with the carbon of the argol fuel, and caused a sputtering beneath the pipkins of the nomads; curiosity and ingenuity combined the materials more intimately, and chance or care added the third ingredient, sulphur. Doubtless the paper cases and bamboos which were charged with the restless, fiery stuff were first of all intended for mere fireworks and dazzling exhibitions; but, as the art advanced, the intermittent firework was introduced, which discharged balls of fire at intervals. This appears among us as the *Roman candle,* — a very absurd name. By taking a tube of increased size, putting in a larger charge, and a missile on top of the latter, we have a fire-arm; and this may have been the condition of the matter when the advanced guard of Alexander was met in Northern India by a people who fought them with "balls of fire," as the ancient historian narrates. The word *canne,* a reed, is well chosen; for the original tube was a *reed* or *bamboo* in all probability, and was also called by that name. The thing and its title have kept well together for two or three thousand years. This sometimes happens, as in the case of two kinds of cloth well known in England, and to some extent here, *barracan* and *camlet.* Falstaff says: — "Two rogues in *barracan* (corrupted into *buckram*) set at me"; not knowing that he was talking Arabic, — *barrakân, barkân,* a garment of camel's hair, from *barik,* a camel. Our gossiping friend Samuel Pepys, and the more stately Sir William Temple, prided themselves on their *camlet clokes,* which, if genuine, were even then made of camel's hair, as they were in the time of Esau and Jacob. The word is about the same, strange to say, in the Aramean and Aryan tongues (Heb. *gâmâl;* Ar. *gamal;* Greek, καμῆλος), which may be accounted for by supposing that the Semitics received the animal and its name from its original proprietors, the men who crossed the Hindoo Koosh, and, occupying the country of the five rivers, became trading acquaintances of the Mesopotamian nations.

Reference to the use of the fire-driven balls occurs at intervals along the pathway of history, and there is but little doubt that the Greek emperors possessed some modes of projecting fire and explosives, perhaps balls, as early as the seventh century. Condé, in his History of the Moors in Spain, speaks of them as used in the attack on fortified places as early as 1118, and at the siege of Cordova, 1280. It is reasonable to suppose that, failing to enter Europe at the Byzantine Gate, the advent would be by the Pillars of Hercules, by which route arrived cotton, paper, clocks, medicines, the present (Hindoo) system of notation, and many other things, including the shirt, its name, uses, and materials (*chemise;* Sp. *camisa;* Ar. *kamis;* not *shirt,* which only means *short,* and has nothing to do with it). Even the Arabic *kamis* betrays the origin of the stuff, being from the Sanscrit *kschauma,* a language of a different family from the Arabic, the name being evidently imported from India by the Arabs along with the material; for the *tree-wool,* as Herodotus calls cotton, was known as an Indian production in the time of the "Father of History," whose credit grows brighter and brighter as years roll by, — tardy justice.

Fig. 1064.



Famous Cannon of the World.

In the eleventh century, if we may credit the chronicle of Alphonso VI., written by Pedro, bishop of Leon, the vessels of the king of Tunis, in the attack on Seville, "had on board a number of iron pipes, out of which volumes of thundering fire were discharged."

In the fourteenth century the references to the uses of cannon became common. Ferdinand took Gibraltar from the Moors by cannon, in 1308. Petrarch refers to them about the same time. The English (at Crecy, 1346), the Moors, Arragonese, French, and Danes, used them during that century.

Metallic cannon were originally made by welding bars of iron longitudinally and binding them by rings, which were shrunk on over them while hot, — a plan which, with some modifications, has been revived of late years, and seems more feasible in the present state of the arts than it was 500 years ago.

Some of these ancient guns were breech-loaders, having a removable chamber, insertable in the breech, where it was wedged, for the purpose of containing the charge of powder.

The balls originally used were of stone, in some cases weighing 800 pounds or more, as is the case of the Mohammed II. gun, mentioned presently.

Fig. 1064 shows the relative sizes, and, to some extent, the mode of construction, of a number of the larger and more celebrated of the pieces of ordnance.

a is the *Tzar-Poosehka,* the great bronze gun of Moscow, cast in 1586. Bore, 122 in. long, 36 in. diameter; chamber 70 in. long, 19 in. diameter; total exterior length, 210 in.; weight, 86,240 pounds.

b, great bronze gun of Bejapoor, India, *Malik-I-Mydan,* the "Master of the Field." Cast in 1548. Bore, 28.5 in.; total length, 170.6 in.; weight, 89,600 pounds.

c, bronze cannon of Mohammed II., A. D. 1464. Bore, 25 in.; total length, 17 ft.; weight, 41,888 pounds.

d, the *Dulle-Griete,* of Ghent, Holland. Wrought-iron, made in 1430. Bore, 25 in.; total length, 197 in.; weight, 29,120 pounds.

e, great bronze gun of Agra, India, *Dhool-Dhanee.* Cast in 1628. Bore, 23.2 in.; total length, 170.2 in.; weight, 67,648 pounds.

f, wrought-iron gun, *Mons Meg,* Edinburgh. Made before 1460. Bore, 20 in.; total length, 159 in.; weight, 12,768 pounds.

g, Michelette le Grand, at Mont St. Michel. Wrought-iron, made in 1423. Bore, 19 inches.

h, Michelette le Petite, at the same place. Bore, 15 in.

i, Mallet's mortar, 1857-58. Bore, 36 in.; weight, 93,840 pounds.

j, English wrought-iron muzzle-loading 35-ton gun. Bore, 12 in.; weight, 48,400 pounds.

k, Krupp's breech-loading steel gun. Bore, 11 in.

l, sea-service mortar. Bore, 13 in.; weight, 11,200 pounds.

m, 68-pounder; weight, 10,740 pounds.

n, Armstrong breech-loader. Bore, 7 in.

For relative sizes of projectiles, see CANNON-BALLS.

The names adopted for cannon in the fifteenth century may be interesting: —

Name.	Weight of Ball.
Aspick	4 pounds.
Basilisk	48 pounds.
Bastard or ¾ carthoun	30 pounds.
Cannon royal or carthoun	48 pounds.
Culverin	18 pounds.
Demi-culverin	9 pounds.

Name.	Weight of Ball.
Dragon	6 pounds.
Falcon	6 pounds.
Falconet	1 to 3 pounds.
Half carthoun	24 pounds.
Moyen	10 to 12 ounces.
Rabinet	16 ounces.
Saker	5 to 8 pounds.
Serpentine	4 pounds.
Siren	60 pounds.

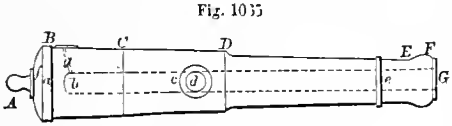
Cannon or ordnance as at present constructed, and used in Europe and America, may be divided into three classes: guns, or cannon proper, howitzers, and mortars. Carronades, which were a short, light species of cannon, intended for firing solid shot at short ranges, with small charges of powder, are now nearly obsolete. They were used on shipboard, and were principally distinguished by having no trunnions, being secured on their carriages or "slides" by a bolt passing through a lug or "navel" cast on their under side, and by a peculiar internal and external chamfer at the muzzle; the name is derived from that of the foundry on the river Carron, in Stirlingshire, Scotland, where they were originally cast.

Guns, as distinguished from howitzers or mortars, are intended for firing either solid shot, shells, or case-shot, generally at moderate elevations, and, in the case of smooth-bore guns, with comparatively high charges of powder, varying, according to the species of projectile and the object desired, to from ⅙ to ⅓ the weight of the solid shot proper to the caliber. The *bore* at the *muzzle* has a slight chamfer. The perpendicular portion of the muzzle is the *face*.

The different parts of a gun or howitzer are designated as follows: the *breech*, including the whole mass of metal in the rear of the bottom of the bore, and extending to the rear of the base-ring; the *cascabel*, including the base of the breech and knob; the reïnforce, or reïnforces, including the thickest part of the gun in front of the base-ring and extending forward to the *chase*, or conical part which terminates at the *neck*, or thinnest part of the gun, where the swell of the muzzle begins; or, should there be no swell, all the part in rear of the face of the muzzle is included in the chase. The *trunnions* are short journals which support the gun on its carriage, the width of which is determined by the distance between the *rimbases*.

In the accompanying section of a 32-pounder gun, from *A* to *B* is the *cascabel*, *A* being the knob of the

Fig. 1055



32-Pounder Sea-Coast Gun.

cascabel and *f* the *base* of the *breech*; *a* is the *base-ring*; from *a* to *C* is the first, and from *C* to *D* the second *reïnforce*; from *D* to *E* is the *chase*, expanding into the *swell* of the *muzzle F*, which terminates in the *lip G*; *b* is the ellipsoidal bottom of the *bore*, indicated by the dotted lines; *c* shows the diameter and position of a *rimbase*, and *d* that of a *trunnion*. The diameter of the latter in guns is usually the same as that of the bore, and in howitzers, and mortars of the old pattern, as that of the chamber. *e* is the *chase-ring*, an ornamental fillet. The position of the *vent* is shown at *g*; its diameter is invariably two tenths of an inch. Rifled guns have a vent-piece of wrought-copper screwed into the piece.

Guns for use on ship-board have a slot in the knob of the cascabel to receive the *breeching*, a stout rope secured to ring-bolts in the side of the vessel for the purpose of checking the recoil.

Rifled cannon were first employed in actual service in Louis Napoleon's Italian campaign of 1859. General James's, 1861, were the first introduced into the United States service. These were service-pattern smooth-bores, rifled and furnished with projectiles also invented by General James. Captain Parrott's gun soon followed James's. This was constructed by shrinking a wrought-iron reïnforce over the breech of a cast-iron core, and was noted for its fewness of grooves and smallness of caliber in proportion to the weight of the projectile, which was very elongated. Wiard's gun was of steel, hammered and welded, and was accompanied by a peculiar and novel carriage. The 3-inch "Ordnance" or Griffin gun was finally adopted for rifled field-artillery, and large numbers were in service at the close of the civil war in the United States. This is a wrought-iron gun weighing about 820 pounds, rifled with 7 grooves, and carrying a projectile weighing about 10 pounds. A cast-iron rifled siege-gun, 4½-inch caliber, and carrying a projectile weighing about 30 pounds, was introduced into the service at the same time.

About 1812, Colonel Bomford, U. S. A., introduced a chambered gun called by him the columbiad. These were made thicker at the breech and thinner at the muzzle than was then customary. This form was somewhat modified in the shell-guns of Colonel Paixhans, of the French army, about 1822, which found their way into the United States land-service at a later period under the name of sea-coast howitzers.

Experiment has gradually led to the practice of increasing the thickness of ordnance at the breech and reducing it at the muzzle, and making the resisting surfaces curvilinear. A large share of credit in this respect is due to the late Admiral Dahlgren, U. S. N.

The Rodman gun, from the late Colonel Rodman, U. S. A., resembles in general form the Dahlgren gun, but is cast with a core, through which a stream of water circulates while cooling, instead of solid, in the ordinary way; this tends to harden the metal in the immediate vicinity of the bore and increase its tenacity. This mode of casting is principally applied to the larger calibers, from 8 to 20 inches. A gun of the latter size, weighing 116,000 pounds, throws a projectile of nearly 1,100 pounds upwards of 4½ miles at an elevation of 25°, with a maximum charge of 200 pounds powder.

The extreme length of the piece is 20 ft. 3 in.; of bore, 17 ft. 6 in.; and greatest diameter, 5 ft. 4 in.

The Crimean war (1854) imparted quite an impulse to the improvement of ordnance and projectiles.

Lancaster's, one of the first of these, obviated rifling by making the bore elliptical, but with a gradual twist throughout, so that a projectile of corresponding shape would receive a rotary motion during its passage through the bore.

Armstrong's first gun was made in 1855, and a patent obtained in 1857. It has been extensively adopted in the British service. It is built up of layers of wrought-iron bars twisted spirally in reverse directions over a steel core, and bound together by one or more wrought-iron rings shrunk on at a white heat. A peculiar breech-loading mechanism is also used with this gun. See Armstrong Gun.

In the Ames cannon, a series of compound longitudinal rings are consecutively welded to a concave breech-piece, upon a removable mandrel.

Blakeley's cannon is composed of an inner tube, which may be of *mild* steel, upon which an outer tube of less extensible material, as hard steel, is shrunk. His first English patent was in 1855. The American patent, in which the process here mentioned is described, bears date 1864.

Whitworth commenced experimenting about 1855, and his guns underwent a satisfactory test in 1860. The leading peculiarities are a bore which is hexagonal in cross section without grooves, and having a rapid twist; the projectile is a hexagonal bolt whose spiral conforms to the twist of the bore and is destitute of knobs and used without a sabot. The device for breech-loading differs from that of Armstrong.

Krupp's first steel cannon (1849) were objected to on account of their novelty and expense. He has since furnished cannon to Asia as well as Europe. He has used a mixture of steel and iron, the latter metal increasing the elasticity.

The compound was cast in plumbago crucibles, and forged while still at a red heat under an enormous steam-hammer, compressing the mass two or three per cent, and nearly doubling its tensile strength. Cannon of over 8-inch bore are made up of several concentric rings; those of a smaller size are forged solid.

Krupp's monster gun, at the Paris Exposition of 1867 (see illustration on opposite page), consists of an inner tube weighing 20 tons, upon which are shrunk cast-steel rings, forming at the breech a threefold and at the muzzle a twofold layer of metal; these are made from massive ingots without welding, weighing together 30 tons.

The total weight of the gun is 50 tons; caliber, 14 in.; total length, 17½ ft.; weight of solid shot, 1,212 pounds; weight of shell, 1,080 pounds; charge of powder, from 110 to 130 pounds. A special car weighing 24 tons was constructed for the transportation of this gun to Paris.

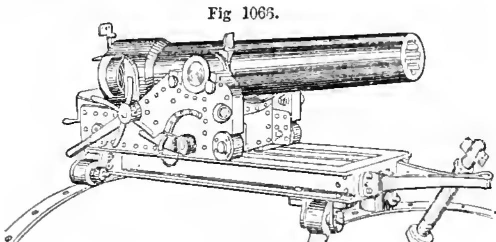
The gun is mounted on a steel carriage weighing 15 tons, supported on a center-pintle chassis weighing 25 tons.

The breech-loading is on Krupp's patent plan. The shot or shell is raised by a block and fall, and is rolled into the side of the breech through an aperture closed by a slide.

Though many breech-loading guns of this or similar construction were employed by North Germany during the late Franco-Prussian war, we know of none at all approaching it in size.

Baron Wahrendorff, of Sweden, some 30 to 40

Fig 1066.

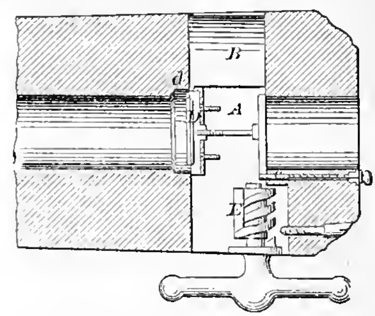


Broadwell's Breech-Loading Gun.

years ago, contrived a breech-loading cannon, in which the bore extended the whole length of the piece, the projectile being passed in at the rear and secured by a transverse breech plug and wedge. Caralli's rifled cannon of later date loaded at the breech in a nearly similar way.

The Broadwell breech-loading cannon has a steel wedge or breech-block *A*, moving horizontally in a mortise *B*, made through the breech of the piece at right angles with the bore. This breech-block is

Fig 1067.



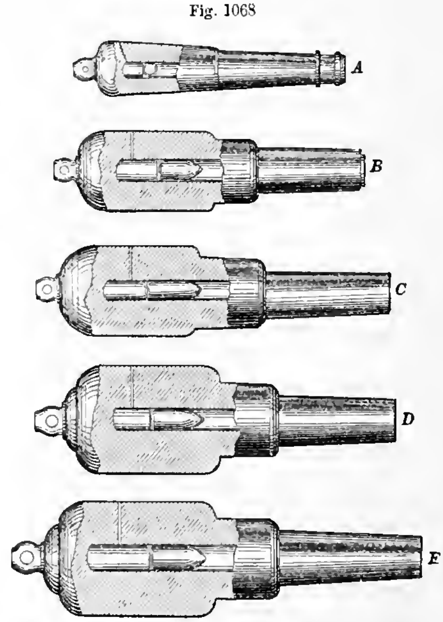
Broadwell's Breech-Block (Detail View).

operated by means of a partially threaded screw, *E*, located in its rear side, which finds its socket-thread in the gun behind it, and is thus locked in position at the moment of fire.

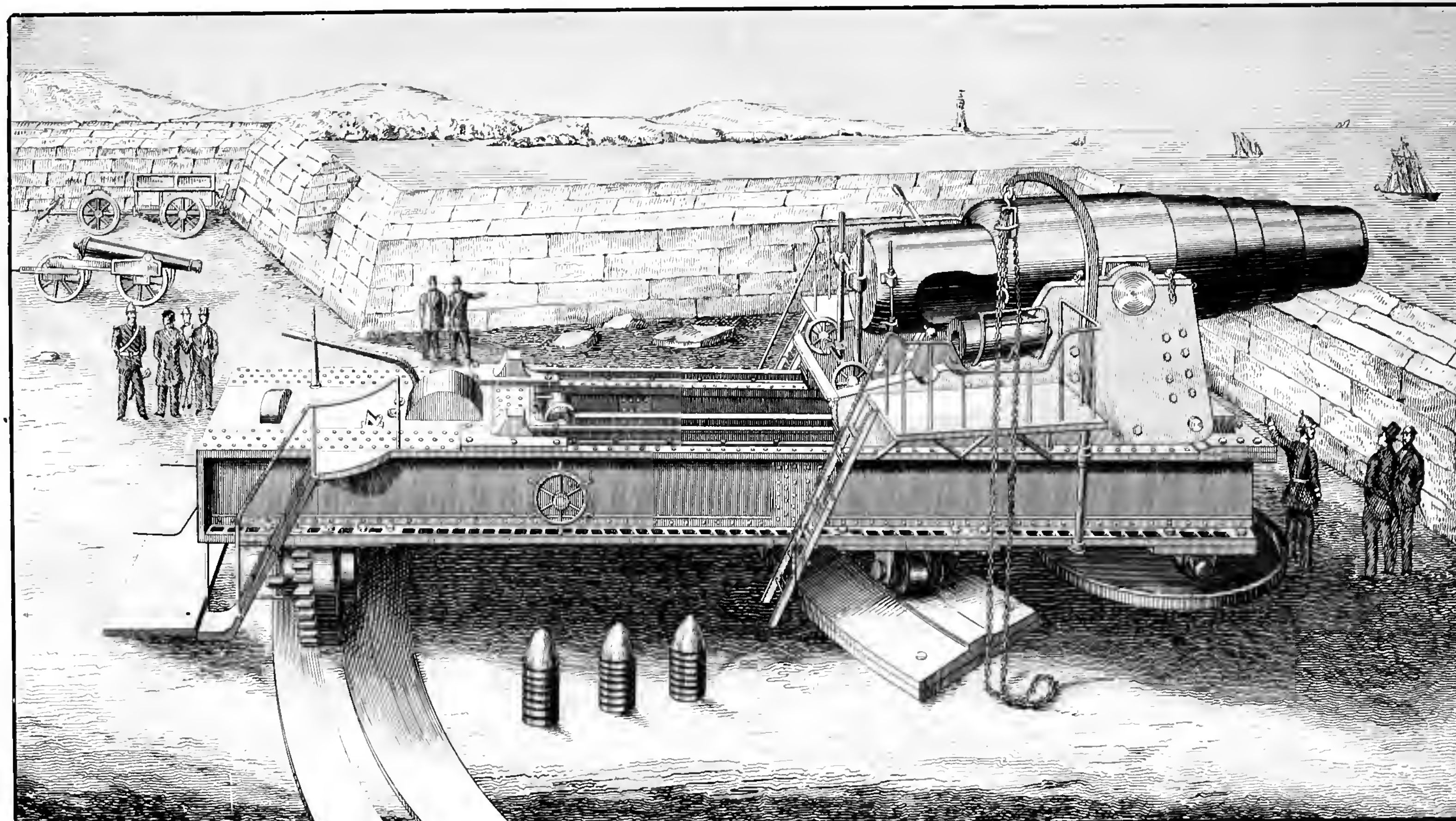
One half-turn of this screw is sufficient to loosen the block, and permit it to be easily withdrawn to the position for loading the piece.

The gas-check consists in a peculiarly curved steel ring *d*, located in a correspondingly shaped chamber in the bore of the gun immediately in front of the breech-block. When the charge is fired, this ring is expanded by the gases and pressed tightly against the walls of its chamber and also against a steel bearing plate, *D*, let into the face of the breech-block, thus forming a perfectly tight gas-check.

Fig. 1068



Armaments of English Iron-Clads.



KRUPP'S 1200-POUNDER BREECH-LOADING RIFLED GUN.

See page 448.

PLATE VIII.

The armaments of the British iron-clads are of heavier and heavier guns as years go by. The annexed figure gives a comparison of the relative proportions and weights of the guns: *A*, "Warrior's" armament, — 68-pounder; $4\frac{3}{4}$-ton gun. charge, 16 pounds. *B*, "Bellerophon's" armament, — 250-pounder; 12-ton gun; charge, 43 pounds. *C*, "Hercules's" armament, — 400-pounder; 18-ton gun; charge, 60 pounds. *D*, "Monarch's" armament. — 600-pounder; 25-ton gun; charge, 70 pounds. *E*, "Thunderer's" armament, — 600-pounder; 30-ton gun; charge, 100 pounds.

These figures are exceeded by the latest English gun (the 35-ton), which is by no means, however, what it is paraded as being, — the largest gun in the world.

	Pounds.
Woolwich, 35 tons 7 cwt. (English count) =	79,084
Armstrong (Big Will)	50,400
Krupp, 14-inch (1,080-pounder)	100,000
Rodman, smooth-bore (20-inch)	116,497

The "Thunderer," 4,400 tons, and the "Fury," 5,000 tons burden, are designed each to carry four of these 35-ton guns, in two turrets, two guns being placed in a turret side by side.

Among the earliest cannon made in Europe were *breech-loaders*, specimens of which are preserved in the Artillery Museum of Woolwich, England.

The charge was inserted in an iron cylinder, which was fixed by wedges in its place in the breech of the gun.

Breech-loading cannon were introduced by Daniel Spekle, who died in 1589, and by Uffanus.

Cannon of ice were made at St. Petersburg in 1740, and repeatedly fired, — a whim.

All the rifled cannon in the British service of less than 6.3-inch caliber are breech-loaders.

At the siege of Badajoz, the firing was continued for 104 hours, and the number of rounds fired from each 24-pounder iron gun averaged 1,249; at the siege of St. Sebastian each piece was fired about 350 times in $15\frac{1}{2}$ hours. But few of these pieces were rendered unserviceable; but it is estimated that three times the number of brass guns would have been required to produce the same effect, or maintain such long and rapid firing.

An experimental Armstrong 32-pounder, weighing 26 cwt., with a charge of 6 pounds and an elevation of 33°, sent its projectile 9,153 yards. The range was carefully measured. Mr. Whitworth states that his little 3-pounder, fired at Southport, attained a range of 9,688 yards. The long experimental 7-inch gun of six tons, designed by Mr. Lynall Thomas, with 25 pounds of powder, propelling a shot of 175 pounds, and fired with an elevation of $37\frac{1}{2}$°, ranged 10,075 yards. There have been several other instances of long ranges, and there would be more but for the general uselessness of firing at distances where no aim can possibly be taken.

The accelerating principle has been again and again suggested, and consists in increasing the velocity of the projectile by the ignition of successive charges of powder during the passage of the ball through the bore. Henry Bessemer, and Captain Fitzmaurice of the British navy, are yet inventing and confident. The former designs a tube 60 feet long, with charges 60 in number, fired by electricity in quick succession, so that each may exert its force before the ball escapes at the muzzle.

Moncreiff's plan for mounting ordnance is to make the recoil of the gun in firing swing the gun backward and downward, so as to depress it below the sill of the embrasure and allow the gunners to load it without exposure to the enemy.

Various modes of mounting and operating guns have been devised for monitor and turret use, for which consult patents of Eads and Ericsson. Very ingenious indeed are many of these devices.

2. (*Machinery.*) A metallic hub or sleeve, fitted to revolve on a shaft or with it.

Can'non-ball. Properly speaking, this term should only be applied to spherical solid projectiles; but it appears to have become generic, extending to elongated bullets for rifled guns, and even to hollow projectiles.

Technically, balls are termed solid shot, or simply shot, to distinguish them from hollow projectiles. They are now universally made of cast-iron, though stone was formerly employed, and was used in some instances by the Turks as late as 1827.

In South America balls of copper were formerly used, this metal being there, at that period, cheaper than iron.

The *Fœdera* mentions an order of Henry V., A. D. 1418, to the clerk of the works of his ordnance, for making 7,000 stone balls for his cannon, of different sizes, from the quarries of Maidstone, in Kent. Although *iron* balls are noticed as being used by the French towards the close of the 14th century, yet no mention is made of them in English history before 1550, when, in an acquittance for delivering up the artillery at Boulogne, they are styled *bouletz de fer*. Stone balls were not entirely laid aside in England till the civil war, time of Charles I.

Elongated bullets for rifled cannon are now frequently, especially by English writers, termed "bolts." These are often made flat-pointed or angularly pointed, to more readily penetrate iron plating. (See *m*, Fig. 1069).

Shells are hollow projectiles in which is placed a quantity of powder sufficient to burst them when exploded by means of a fuse. See FUSE; SHELL.

Case-shot are thinner than shells, adapting them to contain a number of bullets, which are scattered at the moment of bursting.

All projectiles are made smaller than the bore of the gun which they are intended to fit. The difference between their diameter and that of the bore of the gun is termed the *windage*. This is much less for rifled than for smooth-bore arms, the former in some cases amounting to .15, and the latter usually to .025 of an inch.

Of the class adapted for rifled guns, those most prominent during the late civil war in this country were the Parrott, Hotchkiss, and Shenkl. See SHELL.

Projectiles for rifled cannon may be given a rotary motion by the expansion of a soft metallic sabot at the rear, or by means of studs cast on or affixed to the shell. The former by their expansion at the moment of firing fill the grooves, while the latter are necessarily compelled to follow the grooves, being unable to leave them without being torn away.

Fig. 1069 shows a few of the numerous kinds of cannon-projectiles which have been devised.

a, the "Hotchkiss." At the moment of firing, the wedge-shaped piece, shown in section, is driven forward, expanding a soft metal ring which fills the grooves.

b b, the "James." The gas passes through the aperture at the back, driving out a number of pins, which expand a fibrous mass surrounding the shot and encircled by a metallic ring, which is thus forced to enter the grooves. In the second this is effected without the aid of pins.

c c are vertical and longitudinal sections of a similar projectile having a detachable point.

d, "Read." The gas enters through holes around the base, and expands an encircling band.

e, "Shaler." Driving forward the metallic cup at the base flattens it and expands the sabot.

f, "Cochran." A band of copper wire is expanded by forcing forward a cup at the base of the projectile, against a cylinder which surrounds the latter.

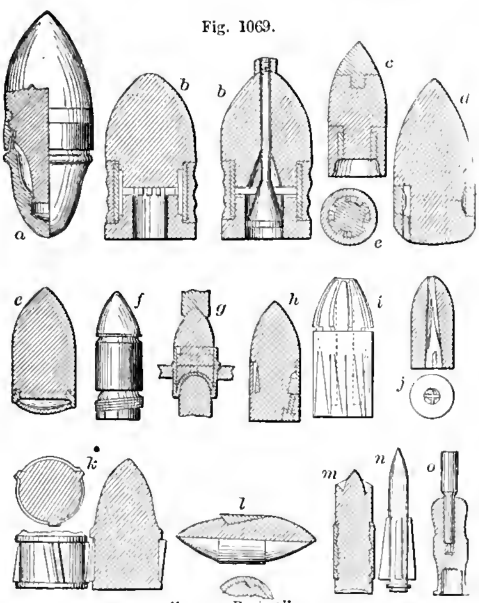
g, "Boekel." The illustration shows the annular soft-metal packing being attached to a projectile by a swage and dies while the point is held on an anvil.

h, "Atwater." The packing of wire webbing or cloth is expanded by wedges driven forward by plungers at the base of the shot.

i, "Woodbury," a spirally grooved projectile, with a sabot similarly grooved, for firing from a smooth-bore gun.

j, "Taggart," has a spirally flanged central aperture intended to cause the bullet to rotate on its

Fig. 1069.



Cannon-Projectiles.

axis by atmospheric action when fired from a smooth-bore gun.

k, "Sigourney," has projecting spiral ribs to take the grooves and impart rotary motion, and annular belts which fit the lands and direct the flight.

l, the "Currie" ball, conoidal at each end, and having an annular groove deepening from front to rear, into which is cast a soft-metal packing-ring.

m, a "bolt" with chisel-edged points for cutting through iron plating. The annular groove between the cutting-edges and the point is filled with soft metal, to prevent retardation of the flight.

n, an elongated bullet with spiral flanges for imparting rotary motion when fired from a smooth-bore gun. It will be obvious to practical men that some of the last projectiles figured would be of little service.

o, an "accelerating" projectile. This bullet has in front a plunger, which, on striking an object, explodes, by percussion, a charge contained in a chamber, giving a new impetus to the projectile.

For varieties of cannon-shot, see under the following heads: —

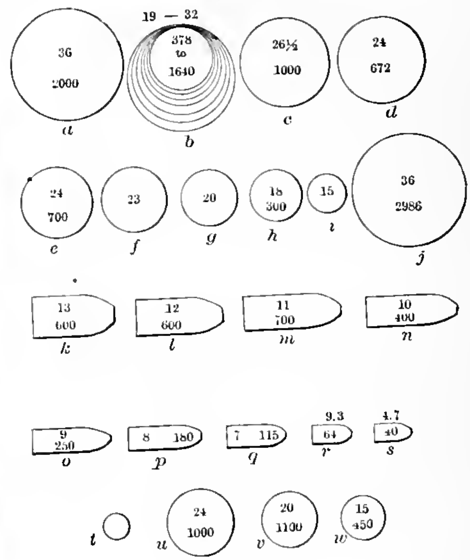
Angel-shot.
Bar-shot.
Bolt.
Bomb.
Burrel.
Canister.
Carcass.
Case-shot.
Chain-shot.
Cross-bar shot.
Double-headed shot.
Grape-shot.
Langrel.
Nail-shot.
Round shot.
Sand-shot.
Segment-shell.
Shell.
Shrapnel.
Spherical case-shot.
Sub-caliber shot.
Tier-shot.
Trundle-shot.

See also PROJECTILES, for list of other missiles impelled by discharge from cannon.

See also WEAPONS.

Fig. 1070 gives an idea of the proportionate magnitudes of some of the projectiles of celebrated can-

Fig. 1070.



Cannon-Balls.

non. The diameters and weights are inscribed in figures; the upper figure being the bore, the lower figure the weight, of the shot. (The balls *a t i*, in the figure, are of stone.)

For description of the cannon themselves, see CANNON.

In Fig. 1070, *a* is the stone projectile of *Tsar-Pooschka* (Muscovite).

b shows seven sizes of the Turkish granite balls of Scutari, weighing respectively 373, 498, 747, 810, 871, 1,182, and 1,640 pounds.

c is the basalt ball of *Malèk-y-mydan* (Indian).

d is the granite ball of the great gun of Mohammed II.

e, the stone ball of *Dulle-Griete* (Flemish).

f, stone ball of *Dhool-Dhanee* (East Indian).

g, stone ball of *Mons Meg* (Scotch).

h, granite ball of *Michelette le Grand.*

i, granite ball of *Michelette le Petite.*

j, Mallet's iron bomb (English).

k to *s*, English elongated iron projectiles.

t, 68-pound ball (1841).

u, Liege, French, 1,000-pound ball (1832).

v, "Beelzebub" and "Puritan," American, 1,100-pound ball (1866).

w, Rodman, American, 450-pound ball (1866).

Can'non-cast'ing. The molds for brass cannon are formed by wrapping a long taper rod of wood with a peculiar soft rope, over which is applied a coating of loam, which, as the work proceeds, is dried over a long fire, a templet being applied to form the proper outline. This model is made about one third longer than the gun is to be. It is next, when dry, blackwashed, and covered with a shell of loam not less than three inches thick, secured by iron bands, which is also carefully dried. The model is next removed by withdrawing the taper rod and the rope, and extracting the pieces of loam. The parts for the cascabel and trunnions are formed upon wooden models, and then attached to the exterior of the shell; handles, dolphins, or ornamental figures, are modeled in wax, and placed on the clay model previous to molding the shell, from which they are melted out before casting.

When dry, the shells are placed muzzle upward in a pit in front of the furnace or furnaces, and the earth thrown in and well rammed around them. At the same time, a vertical runner, which enters the mold near the bottom, or not higher than the trunnions, is made for each mold, terminating in a trough or gutter, at the far end of which is a square hole to receive any excess of metal. The runners are stopped by iron bars, which are successively withdrawn as the preceding mold in order becomes filled, and the furnace or furnaces are tapped by an iron bar with a taper end, so as to regulate the flow of metal, by making a larger or smaller orifice, as required. A spade or gate across the gutter at a certain point prevents the metal from flowing beyond this till the molds towards that end are filled, and when the last is removed the metal is allowed to flow into the square pit before referred to.

The general process with iron cannon is very similar. In all such large castings a large head or sprue must be allowed to maintain a pressure adequate to produce a sufficient solidification at the breech, where the metal should be strongest.

In casting the first 20-inch gun at Fort Pitt Foundry, in 1864, the mold was in four pieces; the core was on the Rodman plan, a fluted cylinder of cast-iron, circular or semi-elliptical at the lower end, and closed at top by a cap through which a pipe enters, conducting water to the bottom, from which it rises to near the top, and is carried off by a waste-pipe.

Five furnaces, charged in all with 105 tons of metal, were employed, — two containing 23 tons, one 39, and the two smaller between 5 and 10 tons each. The molten metal was admitted to the bottom of the mold through two gates, one on each side. Six hours were required for its complete fusion, which was maintained for one hour twenty-four minutes, when the large furnaces were tapped, filling the mold in twenty-two minutes. So long as a constant flow of water was admitted to the core, the temperature of that issuing from the discharge-pipe did not exceed 92° F., falling within twenty-one hours to 57°; but when the flow was stopped, the temperature rose to the boiling-point. (See page 447.)

Can'non-clock. A cannon with a burning-glass over the vent, so as to fire the priming when the sun reaches the meridian. Such pieces were placed in the Palais Royal and in the Luxembourg, at Paris.

Can'non-lock. A contrivance placed over the touch-hole of a cannon to explode the charge.

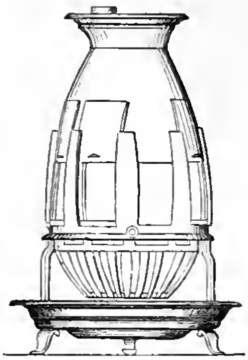
Can'non-met'al. An alloy of copper and tin. See GUN-METAL; ALLOY.

Can'non-pin'ion. (*Horology.*) A squared tubular piece, placed on the arbor of the center-wheel, and adapted to hold the minute-hand.

Can'non-roy'al. An old grade of service-cannon, 8½ inches bore, 66-pounder. A *carthoun.*

Can'non-stove. A cast-iron stove, somewhat cannon-shaped, the lower portion, or bosh, forming the fire-pot and the upper a radiating surface. It has no flues proper, but the stove-pipe stands upon the top, encircling the thimble. The door is above the level of the coals, and the middle zone of the stove may have, as in the example, doors and panes of mica.

Fig. 1071.



Cannon-Stove.

Can'nu-la. (*Surgical.*) A small tube introduced by means of a *stilette* into a cavity or tumor, to withdraw a fluid.

Ca-noe'. A light boat, narrow in the beam and adapted to be paddled.

The *coracle* of the ancient Britons was a frame of willow covered with hides. The North American Indian made his canoe of cedar-wood covered with an unbroken sheet of the bark of the white birch. The Indians of the plains used buffalo-hide. In the wooded regions devoid of birch the canoe was a shaped and hollowed log.

The Rob Roy canoe, so celebrated from the adventures of Mr. Macgregor in traveling 3,000 miles on the navigable streams and head-waters of Europe and Asia, was made of well-seasoned and selected plank. Such a canoe is 13 feet long, 26 inches wide, 12 inches deep, and has a "camber" of 2 inches. The opening in the deck in which the voyager places himself is 4 feet long and 1 foot 8 inches wide. A canoe for two persons, sitting face to face, should be about two thirds larger.

In New York, the form and construction known as the nautilus is most approved, it is made of wood, the keel being oak and the hull of cedar. Abroad, there are several types, all more or less in favor. Assuming the traveler to weigh one hundred and sixty pounds, a nautilus should have a length of 14 feet, and a beam of 2 feet 4 inches. It is lowest amidships, its depth there being 12 inches, rising to 20 at the stern and 22 at the bow. In each end is a water-tight compartment, and the whole is so contrived that in event of a capsize it will right itself as soon as relieved of its burden. It is fitted with a sprit-sail, 7 feet from tip to boom, and is, indeed, calculated more for sailing than paddling, while the reverse is the case with most of the English canoes.

Appliances and means are carried for cooking, fishing, hunting, etc.: and in supplying these minor conveniences much ingenuity and adaptiveness has been displayed. An apparatus heated by a spirit-lamp serves for the preparation of food. Waterproof haversacks carry tea, coffee, sugar, rice, and other comestibles, as well as quinine to cure the ague, which pursues bipeds without feathers who paddle about in wet places.

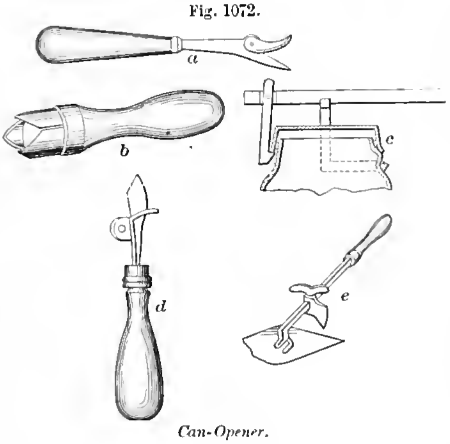
Canoes are also made of galvanized iron, caoutchouc, and paper. The latter comes the nearest in lightness to Hiawatha's: —

"Thus the Birch Canoe was builded
In the valley, by the river,
In the bosom of the forest;

And the forest's life was in it,
All its mystery and its magic,
All the lightness of the birch-tree,
All the toughness of the cedar,
All the larch's supple sinews;
And it floated on the river
Like a yellow leaf in autumn,
Like a yellow water-lily."

The canoes of the Feejees are double, of unequal size; the smaller serving as an outrigger. Large ones are 100 feet in length. The two canoes are connected by a platform about 15 feet wide, and projecting two or three feet beyond the sides. The bottom of each consists of a single plank; the sides are fitted by dovetailing, and closely united by lashings passed through flanges left on each of the pieces. The joints are closed by the gum of the bread-fruit tree. The sails are large, and made of mats. The mast is about half the length of the canoe, and the yard and boom are still longer. Captain Cook estimated the naval force of the Society Islands at 1,700 war-canoes, manned by 68,000 men. See Boat, pp. 311, 312.

Fig. 1072.



Can-Opener.

Can′on. 1. (*Surgical.*) An instrument used in sewing up wounds.

2. (*Printing.*) A large type, used for posters and handbills.

3. The part of a bell by which it is suspended. Otherwise called the *ear*.

Can′on-bit. The barrel of a bit; the portion in the mouth of a horse.

Can-o′pen-er. A domestic implement for opening cans containing fruit, oysters, and what not. The illustration shows several forms.

a has a prong which is thrust through the tin and forms a fulcrum for the cutter.

b is designed to bore a round hole.

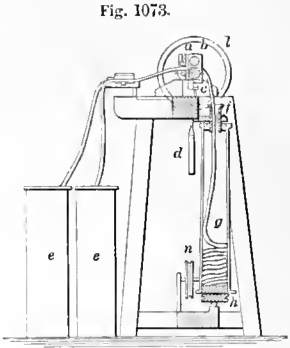
c is a lever-arrangement to pry up the lid of a can which is held down by the pressure of the atmosphere.

d e, like *a*, have points which form fulcrums or centers of oscillation for the cutters.

Can′o-py. (*Architecture.*) A covering or hood, the enriched projecting head to a niche or tabernacle. The tablet or drip-stone, whether straight or circular, over the heads of doors or windows, if enriched, is so called.

Can-rov′ing Ma-chine′. (*Cotton-manufacture.*) In this machine the slivers from the cans *e e* are drawn through the rollers *a b c*, the proper pressure being maintained by a weight *d*, and the consolidated slivers delivered into the can *g*, fixed to a pivot at the bottom, and supported at the neck *f*, while it is made to revolve by a strap passing round the pulleys *n* and *h*. This rotary motion gives the sliver a slight twist, which constitutes it a roving, as it passes in, and coils it up in the can in a regular manner.

Fig. 1073.

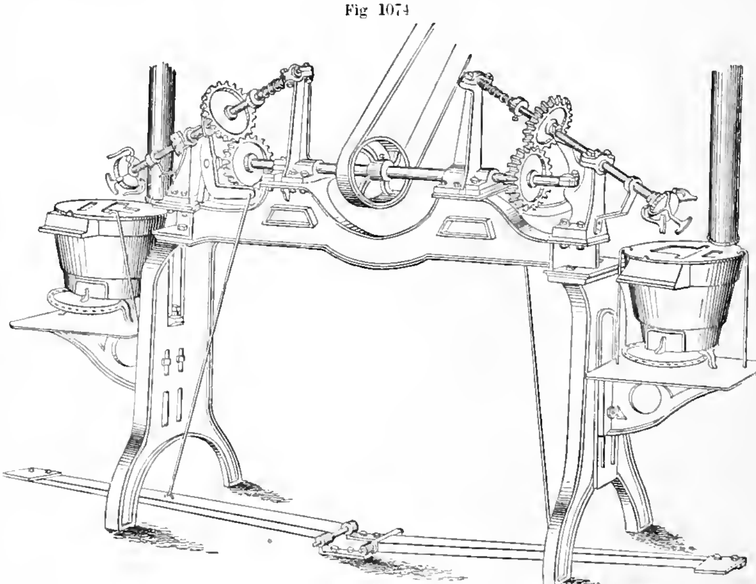


Can-Roving Machine.

When the can is full, it is opened, the *roving* taken out and transported to a roving-machine, where it is wound upon reels ready for spinning.

Can-sol′der-ing Ma-chine′. In this apparatus a clutch on the end of a shaft having a bevel-wheel gearing, with the bevel-wheels turned by the central pulley, is placed at either end of the frame, enabling two workmen to operate at once. Beneath each clutch is a bracket for receiving a soldering-furnace. A can, with its bottom or top inserted, is

Fig 1074



Can-Soldering Machine.

fixed upon the clutch, the treadle being depressed to throw the bevels out of gear, and withdraw the clutch from the surface of the metal in the soldering-furnaces; releasing the treadle, the bevels are thrown into gear, and a spring forces the rod bearing the clutch downward, until the lower edge of the can is slightly immersed in the molten solder, and caused to rotate against the surface of a soldering-iron held therein, after which the treadle is again depressed and the can removed.

Cant. An angle; a bevel; a chamfer; a slope; an arris; a hip; a ridge.

1. (*Building.*) *a.* A *canted* wall is one which forms an angle with the face of another wall.

b. A *canted* column is one whose flutes are formed in cants instead of curves.

c. When the angles are removed or absent from a post, beam, or pillar, it is said to be *canted.*

d. A *canted* molding is one which has angular turns, but no quirks or circular work. See MOLDING.

2. (*Coopering.*) One of the segments forming a side piece in the head of a cask.

3. (*Nautical.*) A piece of wood laid upon the deck of a vessel, to support the *bulkheads.*

4. (*Shipbuilding.*) A *cant-timber* or *cant-frame* is one which is not square with the keel; less than 90°.

5. The angle, as of the head of a bolt. A bolt with a hexagonal or octagonal head is said to be six or eight *canted.*

6. (*Gearing.*) A segment of the rim of a wooden cog-wheel.

Can'ta-lon'. (*Fabric.*) A species of woolen stuff.

Cant-block. (*Nautical.*) A large block used in canting whales; that is, turning them over in flensing. The *cant*-purchase is suspended from the main-mast head.

Cant-board. A division in the conveyer-box of a flour-bolt, to separate grades of flour or offal.

Cant-chis'el. A long and strong chisel with the basil and a rib on one side.

Cant'ed. A term applied to an object when a corner is chamfered off, — not rounded off, but presenting angles. See CANT.

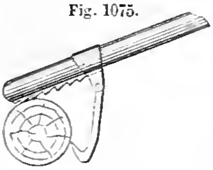
Cant-fall. (*Nautical.*) The purchase used in turning over the carcass of a whale when *flensing.*

Cant-file. A file having the shape of an obtuse-angled triangle in its transverse section; used in filing the inner angles of spanners and wrenches for bolts with hexagonal and octagonal heads.

Kant is an edge or corner in many of the old dialects of Europe, and the Greek κανθός, the corner of the eye, has an allied signification.

Cant-hook. A lever and suspended hook adapted for turning logs in the yard, on the skids, or on the saw-mill carriage.

Fig. 1075.



Cant-Hook.

Also, a sling with hooks for raising and tilting casks, to empty them.

Can'tick-quoin. (*Nautical.*) A triangular block of wood, used in chocking a cask, to keep it from rolling when stowed.

Can'ti-lev'er. One of a series of timbers, of the nature of consoles, projecting from the face of a wall to sustain an eave, cornice, entablature, or balcony. A *modillon.*

Cant'ing-wheel. A star-wheel for an endless chain. The cogs are canted; that is, the corners cut off. See STAR-WHEEL.

Can'tle. (*Saddlery.*) The upwardly projecting portion at the rear part of a saddle. See POMMEL.

Cant'ling. (*Brick-making.*) The lower of two courses of burned brick which inclose a brick-clamp.

Cant-mold'ing. One neither perpendicular to the horizon, nor to the plane of the object to which it is attached.

Can'ton. (*Building.*) A salient corner formed of a pilaster or quoins, which project beyond the general faces of the walls.

Can'ton-flan'nel. (*Fabric.*) Cotton cloth upon which a nap is raised in imitation of wool.

Can-toon'. (*Fabric.*) A strong cotton goods, with a corded surface on one side and a satiny finish on the other.

Cant-timber. (*Shipbuilding*). One of the timbers at the end of a ship which are *canted,* that is, rise obliquely from the keel. The forward pair of *cant-timbers* are called the *knightheads,* and form a bed for the reception of the bowsprit. The cant-timbers towards the stem incline forward; those towards the stern incline aft.

A *cant* is an angle, and the timbers in the narrow interior angles at the stem and stern are called *cant-timbers.*

The timber at the extreme angle is built in solid, and is called the *dead-wood.*

Can'vas. (*Fabric.*) From *cannabis,* hemp. An unbleached, heavy cloth of hemp or flax, used for sails, tents, backing for pictures, bed-bottoms, and for other purposes where a fabric of great stability is required.

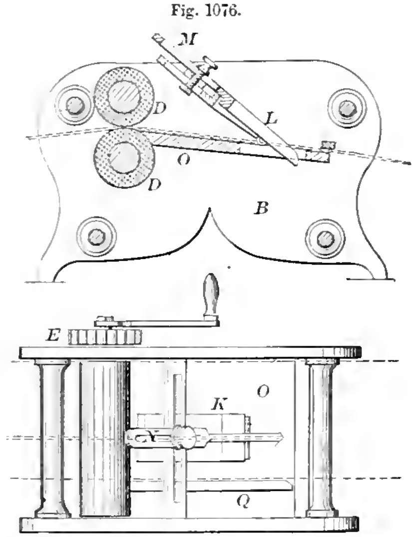
An open variety is used for tambour and worsted work.

Canvas for sails is made from 18 to 24 inches wide, and numbered from 0 to 8, No. 0 being the thickest. A bolt is from 39 to 40 yards long. The best is made of long-fibred flax.

Bolts of canvas weigh from 25 to 48 pounds, and strips 1 inch wide have a tenacity varying from 200 to 480 pounds.

Can'vas-cut'ter. A machine for cutting canvas, card-board, and other sheet materials into strips; the stuff is fed between rollers *D D*, guided by a strip *Q*, and slit by a knife *L*, which is ad-

Fig. 1076.



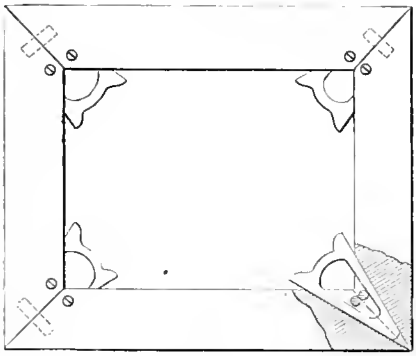
Canvas-Cutter.

justed to such distance from the latter as may be desired.

Can'vas-frame. (*Calico-printing.*) A diaphragm of canvas in a paint-vat used in a certain process of calico-printing. The color is admitted by a stop-cock below, and up to the level of the canvas.

Can'vas-stretch'er. A quadrilateral frame on which canvas is extended for painters' uses. In the

Fig. 1077.



Canvas-Stretcher.

one shown, the miter-joints have dowel-pins, and are expanded by the wedges, the pins in the open center of the latter preventing their falling out.

Caout'chouc. Commonly called gum-elastic or india-rubber. A substance derived from the sap of various trees, of which the *Jatropha elastica*, called by the natives *hevee*, flourishing in the plains of Brazil, toward the lower part of the Amazon River, is the principal source of production. It was first brought to Europe in the early part of the eighteenth century, and fifty years later was mentioned by Dr. Priestly as a substance excellently adapted for removing pencil-marks from paper. Crumb of bread had previously been employed for this purpose.

The sap, obtained by tapping the trees, is dried over a fire, which gives it the dark appearance observable in the rubber of commerce. For many years its various adaptabilities seemed unperceived, but in 1791 Samuel Peal obtained a patent for water-proofing fabrics by means of this gum dissolved in spirits of turpentine; though this does not seem to have led to any practical results. Besides turpentine, ether, bisulphide of carbon, naphtha, some of the volatile oils, and especially benzole, are its best solvents. Acids and alkalies exert but little influence upon it.

Hancock, 1823, and Mackintosh, were the first who really applied this gum to its present uses. Their original processes consisted in applying it, dissolved in some of the fluids before mentioned, to the surface of a web of cloth; this might be doubled, constituting a perfectly waterproof garment; but a mass of such laid together became almost inseparable in warm weather, compelling seamen and others much exposed to wet under the tropics to prefer the old-fashioned oil-cloth overcoat to the "Mackintosh." This was remedied by the vulcanizing process discovered by Goodyear.

The modes of manufacture up to a certain point of the manufacture under the old, or non-vulcanizing, and the present, or vulcanizing, processes, are very similar. The mass of rubber bottles, blocks, or strips, were formerly compacted under a hydrostatic press, and afterward cut by knives, operated by machinery, into sheets and strips as required. For forming elastic or corrugated goods the rubber threads were passed between rolls and kept at their full tension during this process, stretching them to several times their natural length; this caused them, when cold, to lose their elasticity. They were then, either naked, or covered with fine thread of silk or cotton, used as the warp or weft threads for the material to be fabricated, and when this was woven their elasticity was restored by passing a hot iron over the goods. Vulcanizing obviates this necessity.

In the present state of the art, the material is first cleansed by extracting the leaves, bark, dirt, and other foreign substances, as far as can be done by hand, and cut into strips by a revolving knife, and then transferred to large fluted iron rollers termed "crackers," which grind out most of the extraneous materials. From the crackers it is taken to the washing-machine, a large vat where it is cut into small pieces by knives, and where it undergoes a kneading and washing process which removes the remaining dirt and foreign matters. It is next transferred to a grinding-machine, composed of large hollow iron cylinders revolving in opposite directions, where the small pieces formed by the washing-machine are kneaded into a homogeneous mass, and is then left to dry. When sufficiently dried, — which takes, perhaps, several months, — the rubber is transferred to the mixing-machine, in which it passes between hollow iron cylinders, heated by steam through their axes to a regulated temperature, where it is farther ground and more thoroughly incorporated. The vulcanizing ingredients are added at this stage of the process.

These may be varied to suit the caprice of the manufacturer, or to adapt the material more particularly to special uses. The combination, through the influence of heat, of sulphur with the gum, gives it the peculiar properties acquired by vulcanization, though other ingredients are largely added.

Charles Goodyear in his original patent preferred 5 parts sulphur and 7 white lead to 25 caoutchouc. The particular proportions of these and other articles are, however, we believe, generally preserved as secrets among rubber-manufacturers, each having special formulas of his own.

Vulcanized rubber is unalterable at a moderate heat, has not the sticky tendency before referred to, and, when cut into threads for elastic goods, does not require to be subjected to a reheating process. This article may be and has been rendered as hard as horn, and used for combs, knife-handles, and even rolled into thin sheets and employed as a substitute for paper.

The substance called ebonite, invented by Mr. Charles Goodyear, who devoted his whole life to the development of the capabilities of caoutchouc, contains from 30 to 60 per cent of sulphur, and has various other ingredients, as shellac, gutta-percha, chalk, barytes, pipe-clay, or white vitriol, added thereto. It is used for knife-handles, combs, and ornamental articles, being very hard and susceptible of a high polish. Equal parts of gutta-percha and caoutchouc combined with sulphur form a compound resembling horn, and which may be used for the same purposes. Sometimes gypsum, resin, or white-lead, are added to this. See Ivory, Artificial; Hard-rubber; Pyroxyline; Vulcanite.

Caoutchouc, exposed to a heat of 600° F. in a close vessel, yields an oily liquid which is an excellent solvent of the gum itself.

A very tenacious glue is formed by dissolving the gum in coal-tar naphtha, and evaporating the mixture to the consistency of cream, and adding, when heated, twice its weight of shellac. For use, the glue is heated to a temperature slightly above that of boiling water. This is known as *marine glue.*

Cap. 1. (*Wear.*) A cover for the head, with or without a visor, but without a brim.

In early times people went bareheaded. An English law of 1571 commanded all persons except gentlefolks and officials to wear a woolen cap.

The Romans long went without any covering for the head, and ancient statues are bareheaded. Caps were once a symbol of liberty, and manumission of a slave was conferred by the gift of a cap. The general use of caps is referred to A. D. 1449. In the reign of Henry VII., hats were limited in price to 20 *d.* and caps to 2 *s.* 8 *d.*, A. D. 1489 In 1571, an act of Parliament made their wear compulsory, except for maids, gentlefolks, land and office holders. See HAT.

2. (*Architecture.*) *a.* The upper member of a column or pilaster. A *capital ;* a *corona.*

b. A coping of a wall or parapet.

c. A cornice above a door.

d. The upper member of a molding.

3. (*Carpentry.*) *a.* The lintel of a door or window-frame.

b. A beam joining the tops of a row of posts in a frame. A *plate.*

c. The hand-rail of a stairs or balustrade.

4. (*Nautical.*) *a.* A thick, strong block of wood with a round and a square hole through it, used to confine together the head of one mast and the foot of the one above it ; or the jib-boom to the bowsprit.

In smaller craft, a lower cap receives the heel of the topmast, and acts as a substitute for the *fid* and *trestle-trees* used in vessels of a larger description.

b. A parceling or covering at the end of a rope.

5. (*Ordnance.*) *a.* A sheet of lead laid over the vent of a cannon. An *apron.*

b. A copper capsule containing a fulminate, and placed upon the nipple to explode the charge on the fall of the hammer.

6. (*Machinery.*) *a.* The upper half of a journal-box. The lower half is the *pillow.* See PILLOW-BLOCK.

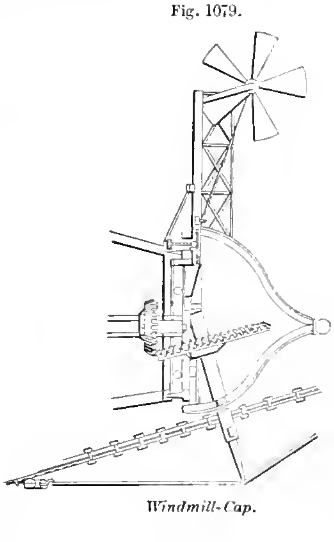
b. The iron-banded piece (Fig. 1078) on the end of a wooden pump-rod or pitman by which it is connected with a working-beam.

7. (*Civil Engineering.*) The horizontal beam connecting the heads of a row of piles of a timber bridge.

Fig. 1078.

Main-Cap.

Fig. 1079.



Windmill-Cap.

8. (*Millwrighting.*) The movable upper story of a windmill. (Fig. 1079.)

9. (*Bookbinding.*) The covering of a head-band or the envelope of a book while binding.

10. (*Horology.*) The inner case which covers the movement in some forms of watches. It is now nearly discontinued.

11. The tire of lead and tin on the periphery of a glazing-wheel.

12. A size of paper. Flat cap is 14 × 17 inches ; double cap is 17 × 28 ; foolscap and legal cap are of various sizes, from $7\frac{1}{2} \times 12$ to the size of a flat cap-sheet folded $8\frac{1}{2} \times 14$. Foolscap is folded on the long edge ; legal cap on the top or short edge.

13. A little capsule containing fulminate, placed on the nipple of a gun, and exploded by the fall of the cock to fire the piece. See PERCUSSION-CAP.

Ca-pade′. (*Hat-making.*) A bat.

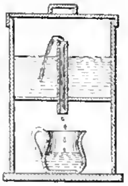
Ca-par′i-son. (*Menage.*) The bridle, saddle, and trappings complete of a horse for military service.

Ca′pel-li′na. (Sp.) The *bell* or cover of the pile of amalgam bricks (*pina*) in the Spanish process of separating the mercury from the metal. See AMALGAMATOR (Fig. 141).

Ca′per. (*Nautical.*) A kind of vessel formerly used by the Dutch as a privateer.

Cap′il-la-ry-fil′ter. A simple mode of freeing water of its larger impurities by means of a cord of loose fiber, such as cotton candle-wick.

Fig. 1080.



Capillary-Filter.

The water in the upper chamber passes into the wick, and, being elevated by the capillary action, passes down the tube, and drops into the pitcher, which is placed in the chamber to receive it.

Cap′il-la-rim′e-ter. An instrument for testing the quality of oils by indicating the quantity of oil which falls from a given-sized point under certain circumstances of temperature, etc.

Cap′i-tal. 1. (*Architecture.*) The head or uppermost part of a column or pilaster. The capitals of the columns constitute the principal and most indicative mark of the respective orders.

2. (*Fortification.*) An imaginary line bisecting the prominent salient angle of a bastion or other work.

3. (*Distilling.*) The head of a still.

4. (*Printing.*) A large or upper-case letter.

Cap′o-niere′. (*Fortification.*) A work consisting of a double parapet, covering a passage across the ditch to the gorge of the ravelin. See BASTION.

Certain differences in construction give rise to the following names : —

Covered or *casemated* caponiere.

Open caponiere.

Single, simple, or *half* caponiere.

Palisade caponiere.

Cap′pa-dine. Silk floss or waste obtained from the cocoon after the silk has been reeled off.

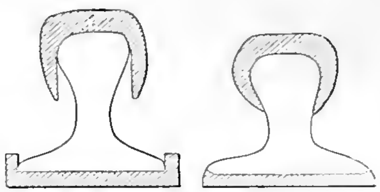
Cap-pa′per. 1. A kind of writing-paper. Ruled with blue lines, and folding on the back, it is *foolscap :* with red lines to form a margin on the left hand, and made to fold on the top, it is *legal cap.*

2. A size of paper from $7\frac{1}{2} \times 12$ to $8\frac{1}{2} \times 14$.

3. A coarse wrapping-paper.

Capped Rail. A railroad rail which has a steel cap attached to an iron body. It is generally made by so disposing the steel in a fagot as to form the edge of that metal, in rolling. It is otherwise

Fig. 1081.



Capped Rail.

known as a *steel-topped* or *steel-headed rail.* See RAIL.

The illustration shows a mode of capping and soling rails as a measure of repair.

Cap'ping-brick. A coping-brick.

Cap'ping-off. (*Glass-making.*) The mode of detaching the closed end of a blown cylinder by drawing a circle around it, bringing it into the shape of an open-ended cylinder ready for splitting longitudinally.

Cap'ping-plane. (*Joinery.*) A plane used for the upper surfaces of staircase rails, which are faintly rounded.

Cap-pot. (*Glass-making.*) A covered glass-pot or crucible.

Cap-scut'tle. (*Shipbuilding.*) The framing of coamings and head-ledges around a hatch and a top which shuts closely into a rabbet.

Cap-square. One of the plates which keep the trunnions of a gun in place. They are secured by keys and chains to the trunnion-plates, which rest in depressions in the cheeks of the gun-carriage.

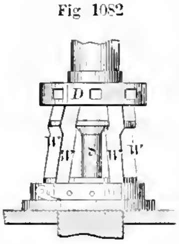
Cap'stan. A hoisting or hauling machine, consisting of a drum set vertically and revolved by handspikes.

Capstans are *single* or *double*, according as they have one or two barrels upon the same spindle. The double-capstan is revolved by two sets of men on two decks.

They are also known as *fore* or *aft* capstans, according to position. The *fore* capstan stands about midway between the *fore* and *main* masts. The *aft* capstan about the same distance abaft the mainmast.

Capstans were used by the ancient Romans in transporting the Egyptian obelisks.

Fig 1082



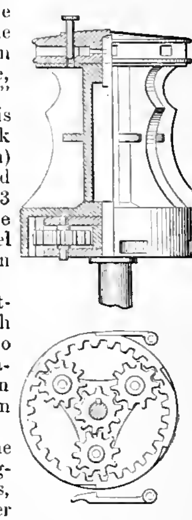
Capstan.

The drum-capstan for weighing heavy anchors was invented by Sir Samuel Morland about 1661. In a simpler form it was used by the English, French, and Spanish in the fifteenth century.

The capstan differs from the windlass in having an upright axle, the bars being placed in the sockets of the *drum-head D*, and revolving horizontally as the sailors walk around, pushing the bars before them, and winding the cable on the whelps, *W*. In this mode of exerting manual power, a force of about 35 pounds is obtained, which is about $\frac{1}{4}$ of what a man can exert upon a windlass, which has a horizontal axis, enabling the men to swing their weight on the bars. The capstan has, however, many advantages, among which may be enumerated — compactness, as it does not stretch across the forecastle of a vessel; facility for allowing a large number of men to work at it simultaneously; continuity of its work, as the bars do not require to be unshipped after making a quarter of a revolution.

The capstan has a central, vertical spindle, which passes through one or more decks, and is securely *stepped* at some point below, according to the size and character of the vessel. The spindle, in passing down through several decks, may have arrangements for being worked by men at several levels. Upon the *spindle S* are firmly attached the several parts. The *drum-head D* has square sockets for the capstan-bars, which are about 10 feet long. Under the *drum-head* is the *barrel*, consisting of the whelps *W*, and beneath the *barrel* is the *pawl-head*, which has a series of pawls around its periphery, engaging the notches in the pawl-rim, which is a circular ratchet attached to the deck. The *drum-head*, *barrel*, and *pawl-ring* are firmly attached to the *spindle* and revolve with it, the cable winding on the *whelps* and the pawls preventing back-lash.

Fig. 1083.



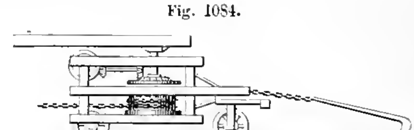
Compound Capstan.

In PHILLIPS's capstan (Fig. 1083), the drum-head is fixed upon the spindle and turns it round. A vertical iron bolt passing through the drum-head locks it to the barrel, and the whole capstan turns round with the spindle, forming a "single purchase." When the locking-bolt is withdrawn, the wheel-work (shown in horizontal section) acts between the spindle and the barrel, and a power of 3 to 1 is gained. The spindle makes 3 turns and the barrel makes 1, and they revolve in opposite directions.

HINDMARSH (English Patent, 1827) added a winch and hand and bevel gearing to the capstan-head, for occasional use. It was partly in the drum-head of the capstan and partly in the barrel.

A portable capstan for the purpose of hauling ditching-machines and mole-plows, moving buildings, and other similar work in which a strong power is to be applied, is shown in the illustration. The chain or rope is wound around the roller, which is in some cases moved by hand-spikes in the hands of laborers, but in the United States is usually moved by a circular sweep and a draft animal or two. It is usually anchored when in use. The sweep is shown as broken off.

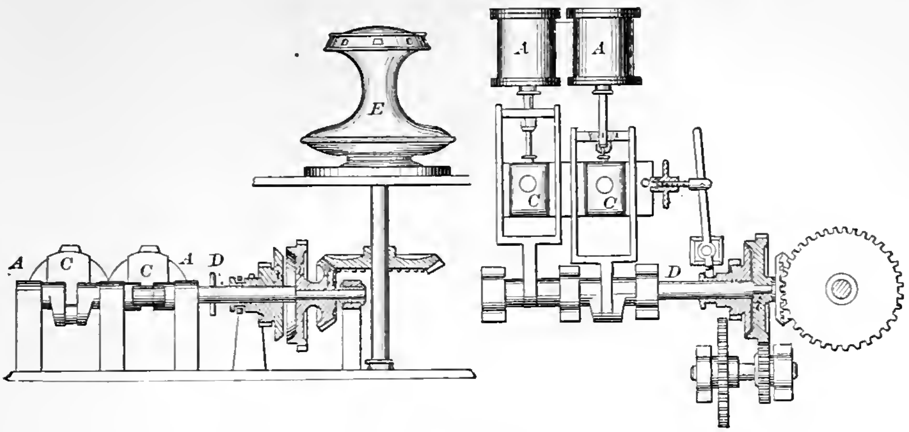
Fig. 1084.



Portable Capstan.

In Fig. 1085 is shown a steam-capstan, in which two cylinders *A A* are connected optionally to the steam-pumps *C C*, or to the shaft *D* of the train, whereby the capstan *E* is revolved. The connections between the pumping-engines and the pumps may be readily uncoupled, and the capstan thrown into gear with said engines. A regulating-screw is combined with

Fig. 1085.



Steam-Capstan.

the friction-clutch, which throws the capstan into gear with the engines, so that the effect of said clutch, respecting the power or speed of the capstan, may be varied.

In moving the mass of granite, weighing 1,500 tons, and used as a pedestal for the statue of Peter the Great, in St. Petersburg, Count Carbury used capstans, the *fall* passing to pulley-blocks, which were secured respectively to the load and to posts set firmly in the ground.

When Vitruvius moved the columns of the Temple of Diana at Ephesus from the quarry to the site, he inserted an iron pin into each end of the column, and to this attached a quadrilateral as long and wide as the column. Oxen were attached to the frame, and the column rolled along on the ground. This was the method devised by Ctesibus of Alexandria. Metagenes, son of Vitruvius, varied the plan in moving the entablature of the same temple, making the iron pivots at the ends of the block work as axles in the hubs of massive wheels. Pæonius suspended his block, which was designed for a pedestal for Apollo, upon wheels in a similar manner. He then united the wheels by scantling, so as to make a perfect cylinder. A rope was wound around this, and uncoiled as the oxen progressed and rolled the cylinder.

Cap'sule. 1. A saucer of clay or bone-ash in which samples of ores or metals are roasted or oxidized.

2. An evaporating dish of porcelain or other ware.

3. A gelatinous envelope for offensive medicine.

4. The shell of a metallic cartridge.

Cap'tive Bal-loon'. One which is tied to the earth by a rope, so as to restrain its ascensive and wandering power.

In the summer of 1868 the largest of its kind was exhibited near London ; it had a cubic capacity of 300,000 feet, an ascensional power equal to eleven tons, from which, however, had to be deducted the weight of car and rope, the latter weighing about four tons. It was capable of carrying thirty people with ballast. To render its ascending power as great as possible, pure hydrogen, obtained from water, in place of coal-gas, was used. The resistance or ascensive power of the balloon required a 200-horse-power engine to overcome it and draw it down. See BALLOON.

Car. A wheeled vehicle.

The invention is ascribed to Erichthonius, of Athens, about 1486 B. C. It will not do. Pliny, and other commentators of his day, knew but little of Egypt. (See CHARIOT ; CART.) Covered and cushioned cars were used by the Romans. (See CARRIAGE.) Triumphal cars were introduced by Tarquin the Elder, 616 B. C. Cæsar relates that Cassibelaunus, of Britain, after dismissing all his other forces, retained 4,000 war-chariots about his person ?

In the United States the term has become restricted almost entirely to vehicles designed for traveling on railways. The varieties are numerous, and are named from their intended use or from some peculiarity in their construction.

Adhesion-car.	Petroleum-car.
Aërial car.	Platform-car.
Box-car.	Provision-car.
Coal-car.	Refrigerating-car.
Dummy-car.	Revolving-car.
Dumping-car.	Safety-car.
Freight-car.	Sleeping-car.
Gravel-car.	Street-car.
Hand-car.	Tank-car.
Irish-car.	Tool-car.
Jaunting-car.	Wrecking-car.

The railway-cars of the United States are carried upon trucks which have a swiveling adjustment beneath the car, to assist in turning curves. This is especially necessary with long cars and on roads with curves of short radius.

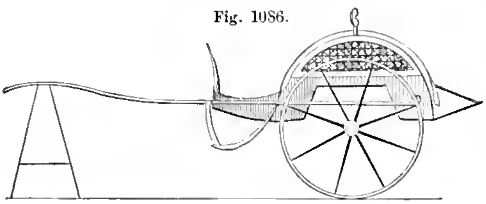
The cars of street-railways, being comparatively short, have pedestals for the axle-boxes attached directly to the bed-frame.

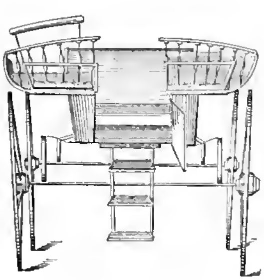
The cars constructed in 1830 for the Liverpool and Manchester Railway, England, had four wheels, but no springs ; the bodies consisting of sills, to which the journal-boxes were bolted, and upon which the floors were laid. These cars were formed without roofs. In 1831, one Mr. Joseph Knight proposed to employ springs under all cars, to support the body of the car and contents, and also suggested that the treads of car-wheels should be made conical, for the purpose of facilitating their passage around the curves of the road.

Cars for the transportation of passengers in England and Scotland consist of three classes, the first class being well finished, and provided with seats for the passengers to sit upon, which seats are furnished with cushions. The second class are of plain finish, without cushions or ornaments. The third class are little more than plain boxes set upon wheels and supplied with seats, but in many cases without any roof. In addition to these three classes, there are what are termed "mixed carriages," which consist of three compartments, the center one being for first-class passengers, and the two end ones for second-class passengers.

The American car has a gangway lengthwise of the car, the seats on each side reversible, so that the car may travel either end forward and yet allow the passenger to "face the horses." It excites the admiration of the average Briton, and will yet be the favorite form of car the world over.

Fig. 1086.





Irish Jaunting-Cars.

3. A kind of two-wheeled Irish vehicle in which the passengers on the two seats sit back to back, facing forward and backward, as in one of the figures; or else sideways, the seats being over the wheels and a well in the center; or else, as in the other figure, a vehicle in which the seats for the passengers face each other, while the driver has a seat in front. Such cars are known as Irish cars, or jaunting-cars.

Car'ack. (*Nautical.*) A kind of large trading-ship, used by the Portuguese in the East Indies.

Car'a-cole. (*Carpentry.*) A term sometimes used for a staircase in a helical or spiral form.

Car'a-co-li. An alloy of gold, silver, and copper, designed for factitious jewelry.

Car'a-core. (*Nautical.*) A light vessel used by the natives of Borneo and the adjacent islands, and by the Dutch as a coast-guard vessel in their East Indian possessions.

Car'at. *a.* A weight of 3.077 grains, used in weighing diamonds.

b. A twenty-fourth part of a piece of gold under assay or estimation.

The name is derived from *Carat*, the sweet-pea, a measure of weight among the Arabs, equal to four grains of barley.

Car'a-van. (*Vehicle.*) *a.* A vehicle for conveying passengers between Cairo and Suez. It is shaped like a light wagon, with top and curtains. A number of them used to meet the passengers arriving by the Red Sea or Mediterranean steam vessels, and convey them across a portion of the Egyptian territory. This route was established by Lieutenant Waghorn.

b. A large inclosed vehicle for conveying wild beasts and other objects of interest in a traveling exhibition.

c. A capacious covered vehicle for moving furniture, etc.

Car'a-van-boil'er. A wagon-shaped boiler.

Car'a-vel. (*Nautical.*) *a.* A small ship, galley-rigged, formerly used by the Spanish and Portuguese.

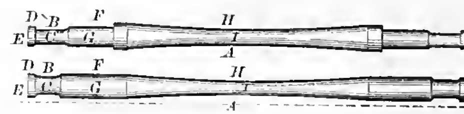
b. A boat used by the French in the herring-fishery.

Car-ax'le. (*Railway.*) The shaft which passes through the *naves* or hubs of the car-wheels, and on which the latter are shrunk or pressed. In the earlier forms of railway car-axles, the wheels rotated on the axles, as in the case of ordinary road-carriages. The practice has long since become almost universal to fasten the wheels of cars to their axles, in order that they may successfully withstand the severe strains and jars to which they are exposed by the weight and surging of the cars and the inequalities of the track.

Axles have been made hollow, to obtain greater strength with economy of metal, but are not in common use, owing to the increased expense of manufacture.

Fig. 1087, *A* shows the form and proportions of an axle.

Fig. 1087.



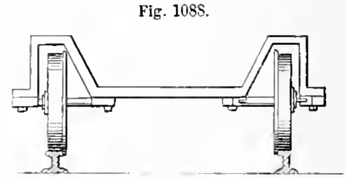
Car-Axle.

E, collar; diameter, $3\frac{3}{4}$ inches.
D, collar; length, $\frac{5}{8}$ of an inch.
B, journal; length, 5 inches.
C, journal; diameter, $3\frac{1}{4}$ inches.
A, axle; length, 6 feet $7\frac{1}{4}$ inches.
F, hub-seat; length, $12\frac{3}{4}$ inches.
G, hub-seat; diameter, $3\frac{7}{8}$ inches.
H, taper; length, 3 feet $6\frac{1}{2}$ inches.
I, middle; diameter, $3\frac{1}{2}$ inches.

In addition to the ordinary form of axle, many devices have been invented, though but few adopted, to obviate special difficulties.

The axle, constructed of one piece of metal, and with the wheels fixed firmly thereon, is subject to severe torsional strain in turning curves, when the outer wheel has a circle of a larger arc to traverse, compelling the wheel on the inner and shorter circle to slip. The torsion of the axle is very detrimental, and the slipping of the wheel is equivalent to grinding on the rail, and retards the train. To avoid these difficulties, the axle has been made in two parts, either by double bearings for the shorter axles, as in Fig. 1088, in which a yoke surmounts the wheels, and is secured to the axle-boxes by screw-bolts, or by some other equivalent arrangement, such as Du Bri's Patent, 1863.

Fig. 1088.



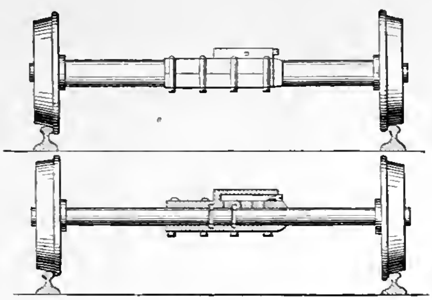
Car-Axle.

Fig. 1089 is an illustration wherein the axle is divided at the mid-length, the inner ends of which are supported in a box or sleeve. See also patent of HEWETT, 1865.

In another form of the divided axle, one portion of the axle is hollow, and forms a sleeve for the other, as in Fig. 1090.

TAYLOR's car-wheel (English patent, May 11, 1841) specifies an arrangement in which one wheel is fixed to a solid axle, and revolves in a hollow axle affixed to the opposite wheel.

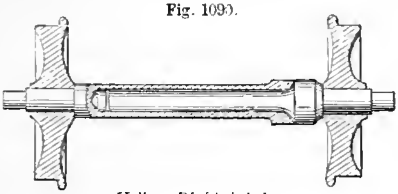
Fig. 1089.



Divided Car-Axle.

These various forms of double axles, which render necessary a multiplication of parts, and consequent

Fig. 1090.



Hollow Divided-Axle.

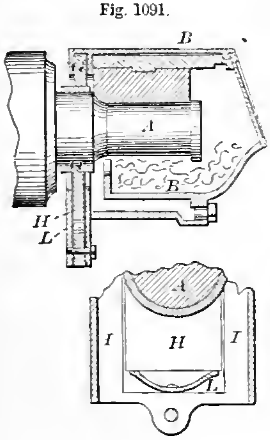
liability to get out of repair, have never come into general use.

Car-Ax'le Box. (*Railway Engineering.*) The chamber which contains the journal of a car-axle, its lubricant, and *brasses*, and which slides upon and down in the *hanger* or *pedestal* as the springs contract or expand.

In Fig. 1091, *B B* is the box containing the lubricant and its vehicle, tow or cotton. *A* is the journal of the axle, having a collar on its end, to prevent its pulling out. A *saddle* has its seat on the journal, and also forms a key for the collar on the end. *G H* are sections with semicircular grooves, which fit upon the shoulder of the journal and keep out dirt and grit. The upper section *G* acts by gravity, the lower section by means of a spring *L L* beneath it. *I I* are guides for the slide-plates *G H*, which bear against the ring *O* shrunk on the shoulder of the axle.

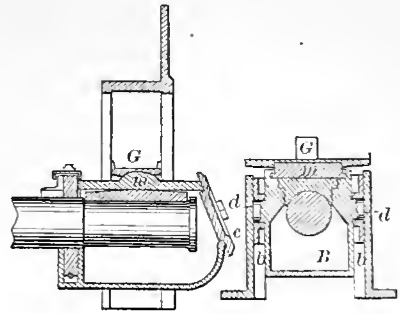
Fig. 1092 shows the relation of the box to the *hanger*, which may also be clearly seen in CAR-TRUCK. The box *B* has trunnions *d d* fitted for sliding blocks *b*, which are adapted to guides formed in the hanger. *G* is the saddle upon which the weight is imposed ; this rests upon a plate *m*, and the latter upon the bearing-block or brass which lies upon the journal. *c* is the axle-box cover.

Fig. 1091.



Car-Axle Box.

Fig. 1092.

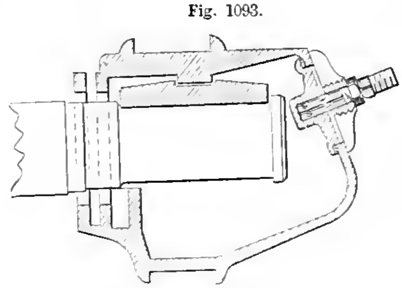


Axle-Box and Hanger.

The English railway axle-box has two pieces, divided at the level of the diameter of the axle, at which point it is fastened together by iron bolts. Brasses surround the bearing portion of the axle, which receives oil from a chamber above. An inclined lid on the outside of the box allows the chamber to be replenished with oil when necessary.

Car-ax'le Box-cov'er. (*Railway Engineering.*) The lid on the upper outer portion of the axle-box, which is lifted to renew the oil and tow or other

Fig. 1093.

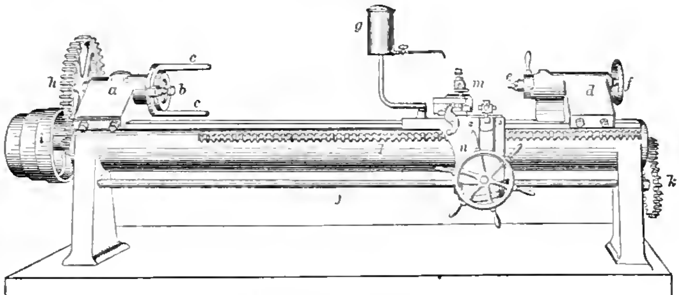


Axle-Box Cover.

lubricating material, and the tow or cotton waste. The lid, usually hinged, fits on an inclined seat, and is secured by latches or otherwise, as in the example, where it is clamped against the inside of the box by a bolt and an outer bridge-piece over the opening.

Car-ax'le Lathe. A lathe specially designed

Fig 1094.

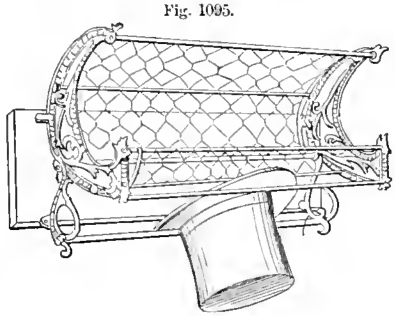


Sellers's Car-Axle Lathe.

for turning car-wheel axles, being strongly geared for heavy cut. The axle is hung upon the centers *b e*, on the head and tail stocks *a d*, and is rotated by the Clement driver *c* on the face-plate, which derives its motion from the gear-wheel *h* and band-pulley *i*. The slide-rest *n*, which carries the cutter *m*, has an automatic feed-motion by the rod *j*, wheel *k*, pinion and connections, and also a rack-feed *l*, with quick hand-traverse. The working parts are fended from chips, and also from the water which drips from the can *g* upon the cutting-tool.

Car-bas'ket. (*Railway.*) A shelf or rack in a passenger car to contain small packages, shawls, satchels, hats, etc.

Fig. 1095.



Car-Basket.

Car'bine. A small arm with a short barrel, adapted for the use of cavalry, and having a bore of .44 or .50 inch, or thereabout.

They appear to have come into notice in the army of Henry II. of France, 1559. The arm was 3½ feet long, and the practice was to fire and fall back behind the rear rank, who fired and followed suit. The troops were light cavalry, and the arm seems to have had a wheel-lock.

The term now is applied to a short gun adapted for cavalry, of which many breech-loading varieties have been tried in the United States army with greater or less success. Previous to the general introduction of breech-loaders, the fire-arm in common use for cavalry, as well as engineers and heavy artillery, was a species of carbine denominated musketoon, differing from the musket only in length and in the fact that the arm for the cavalry was provided with a sling-bar for more convenient carriage on horseback; those for the engineers and artillery were generally furnished with sword-bayonets. These all appear to have corresponded nearly in caliber and general dimensions with the modern French *carabine*.

The *Spencer* rifle was extensively used by the cavalry of the Union army during the late war.

Car'bine-thim'ble. A stiff leathern socket, secured to a *D*-ring on the off-side of the saddle by a strap and buckle. It receives the muzzle of the horseman's carbine.

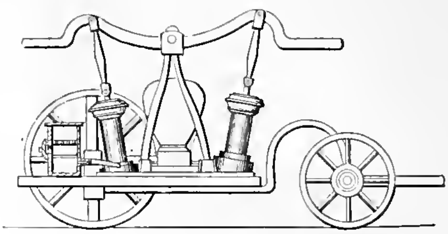
Car'bon-bat'ter-y. Another name for the "Bunsen" galvanic battery, in which carbon or gas-coke replaces the platinum of the "Grove" battery, and a solution of bichromate of potash replaces the nitric acid. The carbon is sometimes in the form of a cup, and thus constitutes the porous cup as well as an element. Sometimes known as the Electropoion Battery, though this is a generic term, and is equally applicable to other forms. See BUNSEN BATTERY.

Car-bon'ic-a'cid En'gine. 1. An engine driven by the expansive power of condensed carbonic-acid gas. BRUNEL'S gas engine, 1804, was driven by the increment of pressure due to the passage of hot water through a coil in the gas-reservoir. See GAS-ENGINE.

2. A machine for impregnating water with carbonic-acid gas as a beverage. See AËRATOR.

3. A form of fire-engine in which water is ejected by the pressure due to the evolution of carbonic acid in a closed chamber over water; or in which carbonic acid is ejected with the water, in order to assist in extinguishing fire by the exclusion of oxygen therefrom. In the example (Fig. 1096), the pumps are made to discharge water, into which a stream of carbonic acid is constantly driven by an air-pump after the water has left the pump-cylinders. See FIRE-ENGINE; FIRE-ANNIHILATOR.

Fig. 1096.

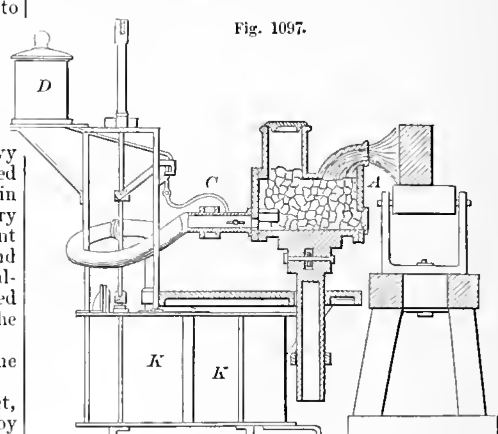


Carbonic-Acid Engine.

Car'bon-iz'er. A tank or vessel containing benzole, or other suitable liquid hydrocarbon, and through which air or gas is passed, in order to carry off an inflammable vapor. See CARBURETOR.

Car'bon-iz'ing-fur'nace. An apparatus for carbonizing wood, disintegrating rocks, etc. Composed of a furnace or fire-chamber, movable upon a stationary frame, both vertically and horizontally, and provided with a nozzle, by which the flame is directed upon the object. The furnace is connected to a blast-apparatus *K K* by means of a flexible tube and a pipe; a fine stream of water flows into this tube from a tube *C* connected with a water-reservoir *D*, and the pipe is surrounded by a water-chamber, to prevent the heat from affecting the flexible tube. The wood to be acted upon is passed before the nozzle *A*, being supported on rollers attached to a suitable frame.

Fig. 1097.



Carbonizing Furnace.

Car'bon-light. The light produced between and upon two carbon points, between which passes a current of electricity. See ELECTRIC LIGHT.

Car'bon-om'e-ter. An instrument to detect the presence of an excess of carbonic acid by its action upon lime-water.

Car'bon-print'ing. In 1838 or 1839, Mr. Mungo Ponton first pointed out the effect of light in producing colorable changes in compounds of bichromate of potassa and organic matters. Mr. Fox Talbot appears to have been the first to appreciate the effect of light in rendering insoluble the compounds of bichromate of potash and gelatine. Poitévin, in 1855, was the first to use carbon, adopting the bichromate of gelatine as a vehicle, availing himself of its insoluble character after exposure. The process was as follows: Paper was coated with a compound of bichromate of potassa, gelatine, and lamp-black, in cold distilled water; this is allowed to dry in a dark room, subsequently exposed beneath a negative for a few minutes, according to the character of the solution and of the light, then dissolving off with hot water the parts not affected by the actinic action of the light. The picture resulting from this treatment is a positive print in black and white, of which the shades are produced by the carbon of the lamp-black. Poitévin also introduced various colors into the same process.

Poitévin, later, introduced another process for carbon-printing under a *positive*. The paper is floated in a bath of gelatine dissolved in lukewarm water and colored with lamp-black. Such paper is sensitized in a dark room by immersion in a solution of sesquichloride of iron and tartaric acid. This renders the gelatine insoluble, even in boiling water. The sheets are dried and exposed under transparent positives in the printing-frame. The parts of the film acted upon by light become soluble in hot water, the iron salts, under the influence of light, being reduced by the tartaric acid, restoring the organic matter to its natural solubility. The sheet is then washed in hot water, which removes the ferruginous compound and develops the picture.

Swann, of Newcastle-upon-Tyne, about 1861, was the first to introduce into a practical process the transfer of the film, after exposure, to another surface, with the face of the film downwards, so as to admit of the dissolving off of the unaltered gelatine and pigment, without undermining the delicate portions of the picture. It will be manifest that the depth to which the actinic rays penetrate the film differs according to the transparency of the negative, and with the light tints will penetrate but a very short distance. With such tints, — when the solution takes place from the face, — when the free gelatine comes to be dissolved, the thin coating of insoluble gelatine and pigment representing the more delicate shades becomes undermined and floats away. Swann, to avoid this, transferred the film with its affected side downward on a sheet of paper, washed from the back of the film, and transferred back again to the paper on which it remained.

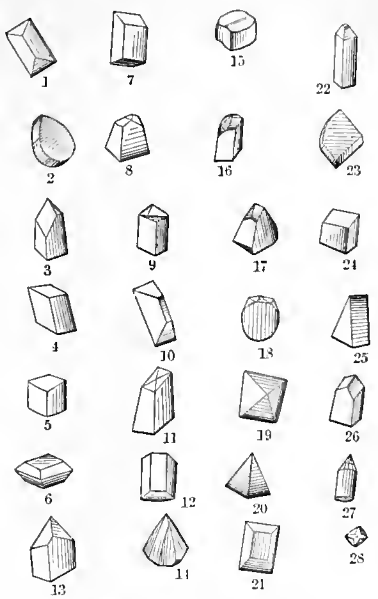
Argentotype is a modified form of carbon picture introduced by Wenderoth, in which the print is backed by a polished plate, to bring up the high lights. Johnson proposes tin as a substitute, cheaper and less likely to tarnish.

The carbon process has been carried forward in several different directions. A hardened film of bichromated gelatine has been pressed in a sheet of lead in a hydraulic press, and a reverse in lead obtained, from which gelatinous casts may be taken. See WOODBURY PROCESS.

The gelatine film carrying the impression is used to print from directly in ordinary ink. See HELIOTYPE.

Car'bon Tool-point. An application of the diamond to mechanical purposes. These points are used to point, edge, or face tools for drilling, reaming, sawing, planing, turning, shaping, carving, engraving, and dressing flint, grindstones, whet-stones, emery, corundum, tanite, or tripoli wheels, iridium, nickel, enamel, crystals, glass, porcelain, china, steel, hardened or otherwise, chilled iron, copper, or other metals.

Fig. 1098.



Dickinson's Carbon Tool-Points.

1 is a triangular prism-like cutter for turning or working stone, etc.

2 is a flat drill-point for drilling stone, glass, or metal.

3 is a burin for cutting or turning metal.

4 is a quadrangular prism for working stone, etc.

5 is a hexahedron to be inserted in the edge or face of a circular saw for cutting stone.

6 is a double-sided trapezoid, used in various positions for marking or turning stone, steel, or other substances.

7 is a chisel point or cutter for turning metal, etc.

8 is a drill-faced parallelogram for pointing combination drills for drilling and reaming stone, metal, etc.

9 is a quadrangular prism with a planer cutting-point for cutting or planing metal, etc.

10 is a truncated prism for working stone, etc.

11 is similar to 8, and used for the same purpose.

12 is a truncated prism used for facing or edging ring or cylinder drills and circular saws for cutting stone, metal, etc.

13 is a quadrangular double-faced drill-point for drilling stone, etc.

14 is a quadrangular pyramid used for reaming stone or metal.

15 is similar to 5, and is used for the same purpose.

16 is a quadrangular cube with graver-edge for cutting metal, etc.

17 is a flat octahedron for drilling stone, glass, etc.

18 is a flat ovoid; with double drill-point, for drilling or countersinking stone, metal, etc.

19 is a tetrahedron, used the same as 18.

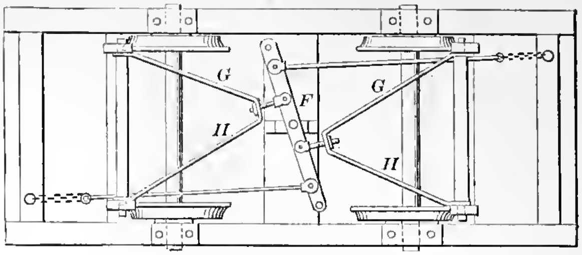
20 is a pyramidical drill-point, used the same as 18 and 19.

21 is a truncated prism, used the same as 1 and 10.

22 is a drill-pointed prism-reamer.

23 is similar to 22, and used in the same manner.

Fig. 1100.



Car-Brake (Plan).

24 is the same as 7, with angular edges, and used for the same purpose.

25 is a double-inclined plane-wedge for cutting stone or metal.

26 is a quadrangular wedge for turning stone or metal.

27 is an acute conical-turned diamond-point, used for engraving, etching steel by bank-note engravers.

28 is a diamond in its natural crystallized state, as found in the mines.

Car′boy. A large globular vessel of green glass inclosed by basket-work or a box for protection. In the latter form the box has rope handles, and the mouth and neck of the carboy protrude through the top of the box. It is used for carrying chemicals, such as sulphuric acid, the *vitriol* of commerce, of which it contains 160 pounds, or 12 gallons of water.

It is like a *demijohn* (*damaghan*, Persian) except in its purpose. The latter is intended to contain spirits.

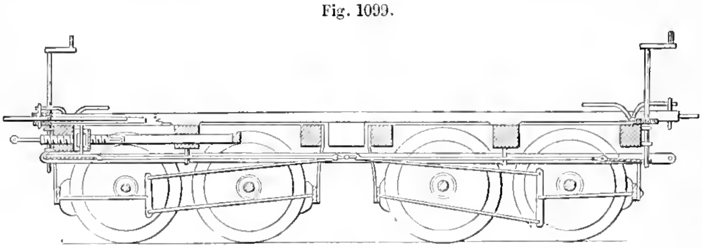
Car-brake. (*Railway Engineering.*) An apparatus by which pressure is applied to the wheels of railway cars, to check their speed and eventually stop their revolution.

The usual accessories are the

Brake-wheel. *Shoe.*
Brake-lever. *Rubber.*
Brake-bar.

1. The brake is usually hand-operated by the brakeman or guard on the car platform or roof, as the case may be. Passenger railway-cars and street-cars have on the platform a brake-wheel or lever, the revolution of whose axis winds up a chain which actuates the levers, rods, bars, and shoes, as in Fig. 1099, and the apparatus is kept at its tension by a click working into a ratchet-wheel on the stem of the brake-lever. The illustration shows an arrangement of longitudinal brake-rods beneath the cars, connected together by chains, so that the brakes are brought into operation if any of the car-couplings give way.

Fig. 1099.



Car-Brake.

One form of the system of rods and bars beneath the car is shown in Fig. 1100, in which a single lever *F*, pivoted at mid-length, is operated by chains and rods from the brake-wheel on either platform. To the lever are attached rods *G H*, proceeding to the brake-bars, which carry the shoes.

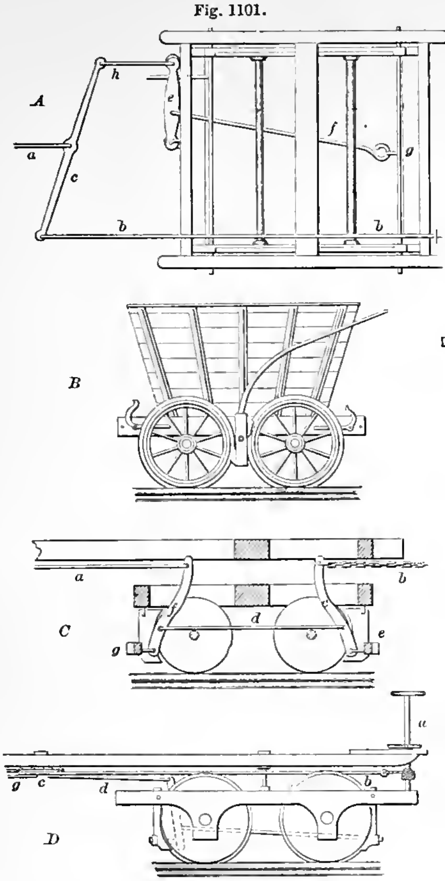
Fig. 1101, *A* is a plan of the Hodge brake, invented in 1849. The illustration shows the portions belonging to one truck; the rod *a* passes to the other truck, where the braking-devices are repeated, so that the action on the wheels of both trucks is coincident and equal, by motion derived from the brake-wheel on the platform at either end of the car. *b* is the rod which is pulled endways by the winding of the chain on the stem of the brake-wheel. This rod *b* pulls upon the lever *c*, which is pivoted at mid-length to the rod *a*, and at its other end by rod *h* to the lever *e*, which is a lever of another order, and transmits to the rod *f* and brake-bar *g* half the power exerted upon *b*. It will be seen that the end of lever *c* attached to the rod *h* is the fulcrum for the attainment of effect on the rod *a*, while the latter is the fulcrum for rod *h*; each is a moving fulcrum, and, the effect upon each being equal, the force of the man upon the brake-wheel is evenly divided between the wheels of the respective trucks.

Fig. 1101, *B* shows the English form of lever-brake for coal or gravel cars. It has a bar pivoted to the frame, and a shoe to act upon each wheel as the lever is depressed.

Fig. 1101, *C* is the Stevens brake, 1851, in which the action of the brakes on the wheels of the respective trucks is also coincident and equal. The drawing shows but one truck, but the rod *a* connects the levers of the respective trucks, so that the operation from either end is effective upon the whole, the result being more thorough if the brake-wheel of the far end be left locked, so as to form an ultimate fulcrum for the system of levers set in motion from the, for the time, operative end. A pull on the chain *b* vibrates the lever *c* on its fulcrum, the rod *d*, and brings the shoe *e* against the wheel; but the fulcrum is itself moved, and, by drawing on the rod *d*, moves the lever *f* and draws the shoe *g* against the other wheel. In effecting this, the upper end of the lever is made the fulcrum; but this is itself movable, transmitting by rod *a* one half of the force originally expended to the braking apparatus of the other car.

Fig. 1101, *D* is another brake of allied nature, the force of the rotation of the brake-wheel stem *a* in winding on the chain being transmitted by rod *b* to a wheel *c* under the center of the car, and thence by rods *d g* to the levers which operate the brake-bars of the respective trucks. The course of the connecting-rod between the two brake-levers of a truck is

Fig. 1101.

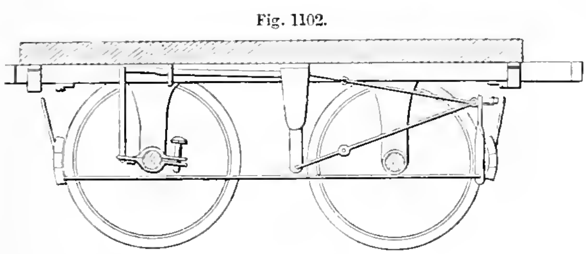


Car-Brakes

drawn in dotted lines, representing it as on the other side of the wheels.

2. The devices are numerous in which the colliding of the cars, as the rate of motion is slacked, or as the brake is put upon the engine or forward car, is made to put the brakes of the train in operation, the effect of the brake-action being proportionate to the energy with which the forward car or engine opposes the momentum of the cars following. One form is shown in Fig. 1102. When the engine is checked

Fig. 1102.



Car-Brake.

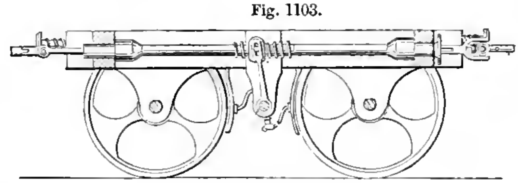
and the buffer-bars come together, the brakes are applied to the cars by power derived from the sliding motion of the buffer-bars and transmitted through the medium of the rods and levers.

The action in this case is by the bumping of one car upon another. In Fig. 1103, the brake-bars of a train are simultaneously worked by means of longitudinal connecting-rods under the car-beds and gimbal-joint connections between cars. The longitudinal screw-shaft turns in bearings in the truck, and operates a nut which is connected to and actuates the brake-levers.

3. Brakes operating continuously throughout the train are found in the patents of Marks, 1854, acting by rods and chains; Stewart, 1859, having rods and cog-wheels; Burrows, 1862, by rods and levers.

Devlan's patent of 1861 acts by grasping the axle

Fig. 1103.



Car-Brake.

of the wheels; Blanchard's, 1866, by a shoe on the rail.

Of the car-brakes exhibited at the Paris Exposition, 1862, Creamer's was automatic, instantaneous, and simultaneously applied to all the wheels of each car.

The machinery of the system in common use remains unaltered, but there is added to it a reserved power in the form of a closely wound and powerful spiral spring, which may be set free by the pulling of a trigger, and which, when free, is a substitute for the force of the brakeman. The apparatus is under the control of the engineer or the conductor, on any car.

With Achard's electro-magnetic brake, each carriage in the train is supplied with a battery of six Daniell cells, connected with each other and with the engine foot-plate by means of four insulated wires passing through the whole length of the train. By means of these electric wires two distinct electric currents may be created, either of which may be closed or broken by altering the position of a handle placed before the engine-driver. The electro-magnetic force upon an armature on each car is made to wind a barrel and draw upon a chain which vibrates the levers and applies the brakes.

4. Another class of car-brakes consists of those in which braking-devices of the cars individually are operated by means of an elastic fluid, air or steam, the operative devices of each car being under the control of the engineer, upon the locomotive.

Steam-operated devices are of different forms: —

a, steam-pipes connected throughout the train and operating a piston in a cylinder on each car, to work the brakes.

b, a rod and chain connected throughout the train, the operative devices being a single cylinder on the locomotive.

c, an air-pipe connected throughout the train, a cylinder and piston beneath each car to operate the brakes, an air-pump on the locomotive to condense air, which is carried by the pipes to all the cylinders in the train.

The Westinghouse Air-Brake employs atmospheric air as the medium for transmitting power to the brakes. This is condensed to the required extent by a steam-pump placed between the driving-wheels or in other convenient position on the locomotive. The air is forced into a reservoir, so that a sufficient supply may be ready for use. From this reservoir it is conducted back under the cars of the train by pipes, connected between the cars by india-rubber hose and valved couplings. Under each car is a cylinder to which the compressed air is admitted forward of a piston, the stem of which is connected to a bell-crank attached to the brake-levers by rods, so that, when air is admitted in front of the piston in the cylinder, the brakes are at once applied to the wheels. See BRAKE, p. 356.

There have been numerous attempts to secure automatic and simultaneous action, throughout the cars of a train, by power derived from a single impulse or operation. Room cannot be spared for their systematic description, but the following patents may be consulted: —

Bessemer (English)	1841	Hodge	1860
Hancock (English)	1841	Dwelley	1865
Nasmyth (English)	1839	Davidson	1860
Petit	1840	Marsh	1864
Birch	1840	Virdin	1859
Carr (English)	1841	Wilcox	1856
Walber	1852	De Bergues	1868
Fuller	1859	Chatelier	1868
Sickels	1857	Lee	1868
Cuney	1855	Ambler	1862
Goodale	1865	Branch	1858
Peddle	1867	McCrone	1865

Car-buf′fer. (*Railway.*) A fender between cars. In the English practice, the ends of the car-frames carry elastic cushions, or buffer-heads with springs. In our practice the spring is usually behind the draw-bar. See BUFFER.

Car-bump′er. An elastic arrangement to lessen the jerk incident to the contact of colliding cars as the rate of speed is slackened. See BUFFER.

Car′bu-ret′or. An apparatus through which coal-gas, hydrogen, or air is passed through or over a liquid hydrocarbon, to increase or confer the illuminating power. They may be said to be of two kinds, though the purpose differs rather than the construction: —

1. For enriching gas.
2. For carbureting air.

The former of the two was the primary idea; the latter was suggested as the matter was developed.

By carbureting the gas you may use poorer coal. Bituminous coal gives off different gases, according to the quality of the coal and the way it is distilled, and gives off different qualities of gas at different stages of the process of distillation. The value of the gas as a lighting medium depends upon the quantity of volatile hydrocarbons; and the object of passing it through the benzole of coal-tar or the volatile oils derived from petroleum is to enrich the gas by the addition of hydrocarbon vapors. Where city gas is not available, air may be carbureted, that is, saturated with the inflammable vapor, by passing it through the liquid. There are many difficulties in perfectly accomplishing the carbureting of air or gas: —

1. The hydrocarbon vaporizes more readily in warm weather than in cold, so that the degree of saturation depends in part upon the temperature of the weather.
2. The liquids used for carbureting air are not homogeneous, but are a mixture of liquids of various volatility; after charging the carburetor, the lighter will pass off first and leave a heavier and less volatile residuum.
3. The amount of vapor taken up will depend upon the speed with which the air passes through the carburetor; so that, when the number of burners is varied, a certain change follows in the quality of the gas.
4. The material is very inflammable, and leaks of the liquid or the vapor are dangerous, requiring special provisions for safety and the attention to charging by daylight.
5. The chief difficulty arises from the fact that the volatilization of the hydrocarbon is affected by the intense cold produced by the evaporation of the liquid.

The working up of the coal-tar oils preceded the discovery of petroleum in commercial quantities.

The primary idea was to force the gas through the liquid.

Carburetors of gas may be defined as those in which material rich in carbon is added to the usual charge of coal in the retort.

Those in which a liquid hydrocarbon is evaporated by the heat of the burner, and mingles with the usual carbureted hydrogen gas.

Those in which the gas is exposed at atmospheric temperature to the liquid hydrocarbon, so as to exhale from the latter a vapor which passes with the usual gas to the burner.

Lowe, in England (English patent 6,276, June 9, 1832), was for enriching the commercial carbureted hydrogen by filling the meter with coal-tar naphtha instead of water, the meter-wheel being driven by the force of the gas from the main. The uniform hight of the liquid in the meter was secured by a fountain arrangement such as is used in lamps, ink-stands, mucilage-cups, and bird-glasses. He subsequently applied (No. 8,883 of March 16, 1841) power to turn the meter-wheel. He also proposed to pass the gas through sponge, or other animal or vegetable stuff or fiber, the said matter being from time to time saturated with naphtha. Also to expose the result to a caustic alkali, to remove the sulphur, and to an acid, to absorb the ammonia.

He also arranged a number of troughs one over another in a box; these discharged into each other by overflow tubes; air is admitted below, sweeps over the surfaces of the liquid in the successive troughs, and passes out at the top.

Also a box having vertical partitions, with sponges, fragments of pumice-stone, or coke impregnated with naphtha, in the compartments, through which the gas passes in succession, up and down, and so on throughout the series.

Selligue, 1834, carbureted hydrogen gas produced by the decomposition of water, and afterwards enriched the products of destructive distillation of wood, resins, oils, etc.

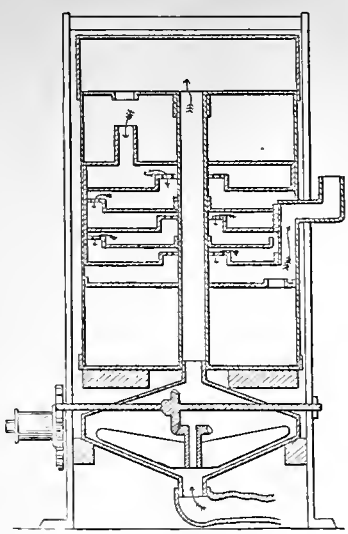
This idea was afterwards followed out by a number of inventors.

C. B. Mansfield, who obtained an English patent (No. 11,960, November 11, 1847), gave a stimulus to the business by the production of a suitable liquid. He did as much, apparently, as could be done with coal-tar benzole, and died from the effects of an explosion of the saturated air.

Drake, 1853, revolved a porous material, to expose a saturated surface to a blast of air.

Adams had a series of overflow pans somewhat as in the cut (Fig. 1104). The air is driven by the rotary fan in the chamber below, through the central vertical pipe to the upper chamber, from whence it passes in a circuitous, reverting, downward course, in contact with the hydrocarbon liquid in the successive trays, and thereby becomes impregnated with vapor.

Fig. 1104.



Carburetor.

Lecarriere, in France, in February, 1853, began by carbureting hydrogen produced by the decomposition of water in the presence of zinc and acid, and then passed to the carbureting of air. He employed a number of cylinders in a box, making a sinuous course for the gas, which enters at the middle, passes down and out through small holes into the second cylinder, and so on. He also introduced a regulating-float.

Marchesson, in 1853, had an upper supply-vessel with a lower chamber, containing a conduit of spiral form, divided by partitions into chambers provided with absorbents, and which communicate by holes. A variation of this was an Archimedean screw moved by the gas, which was enriched by the vaporized liquid.

Launay, 1856, used cotton wicks saturated with oil by capillarity, and exposing a large surface to the passing gas.

Veique, 1857, has a closed cylindrical chamber, with inlet and outlet pipes for the gas, and a revolving helix of wires or a helical frame with wide-meshed cloth.

Varmaique, 1858, has a siphon arrangement for the supply of an upper chamber, which discharges by a pipe at the bottom of the lower chamber; the gas passes through the chambers.

Vesian, 1858, introduced the float operating the valve of the admission pipe for the liquid.

Martin, 1858, added a lamp, to expedite the vaporization.

David, in 1859, used a bulb of displacement, to preserve a constant level, instead of an automatic valve of admission; and this was so arranged as to maintain a uniform light, although the liquid varied in density as evaporation proceeded.

Ashcroft, 1857, had a float to govern the ingress of air, and cause it to pass through a uniform depth of liquid.

Levi L. Hill, 1859, reissued 1863, modified the richness by inlet of air, and had a double bellows for equable blast.

F. S. Pease had a separate tube to condense an excess of liquid.

Lowback, 1860, heated the air.

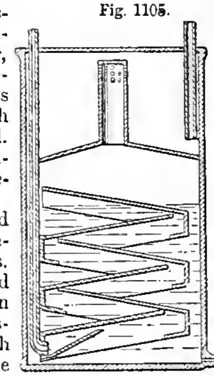
Matters remained in this condition until the discovery of petroleum; the first notice of petroleum benzine was in a Boston paper, September, 1860.

John A. Bassett, by patent March 2, 1862, developed the use of the petroleum liquid, which gives the carburetor its practical value, the gas-tar products being expensive and difficult to manage.

Levi Stevens, December 20, 1864, passed the air through a shower of the liquid, which was dropped into the vaporizer in measured quantities.

Irwin introduced a feature (April 11, 1865) founded on the fact that the hydrocarbon vapor conferred greater gravity upon the air, so that the weight of the carbureted air forced itself to the burner and dispensed with a blowing apparatus. He also used a caloric engine to produce a motive-power to generate a blast of air, and the escaping heated air was carbureted.

Fig. 1105.



Pease's Carburetor.

Boynton, 1865, dispensed with moving machinery in the chamber, by making a plain metallic box with a fibrous material inside, through which air was forced. He also mixed the benzoles of gas-tar and petroleum.

Myer, 1865, washed the carbureted air, to remove extraneous matters.

Pease, 1865, injected air at the lower portion of the carburetor, causing it to ascend through fluid in contact with the lower surfaces of a series of inclined planes with flanged edges and ends, passing from one incline to another in a zigzag upward course into the chamber, from whence it is withdrawn for use.

After this the inventions became very numerous, having reference mainly to detail: to regulate the admission of air, the egress of carbureted air, the graduation of the quantity of liquid admitted, a forced circulation in the carbureting chamber; to regulate the temperature of the liquid, the air, and the result; means for drawing off the heavy oil.

As means of forcing the air: —

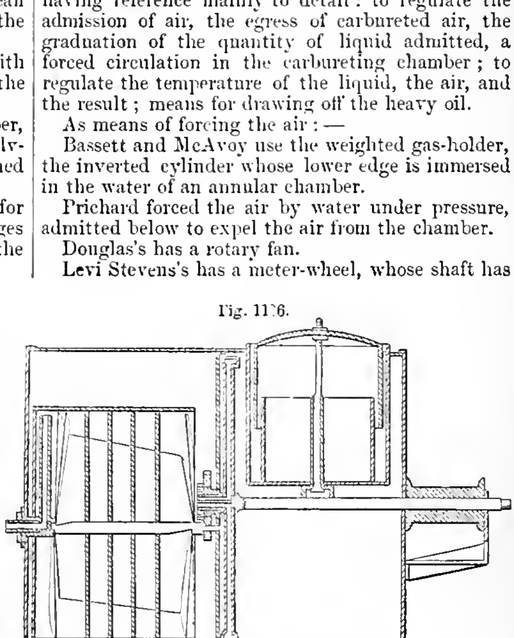
Bassett and McAvoy use the weighted gas-holder, the inverted cylinder whose lower edge is immersed in the water of an annular chamber.

Prichard forced the air by water under pressure, admitted below to expel the air from the chamber.

Douglas's has a rotary fan.

Levi Stevens's has a meter-wheel, whose shaft has

Fig. 1106.



Carburetor.

its bearing below the center of the partition dividing the meter and regulation chambers, and gears with a wheel on the regulator-shaft, which has a bearing at the center of the partition. Both chambers are partially filled with carbureting liquid. Air is introduced to the top of the meter-chamber. As the air is carbureted it is conducted to the regulating-apparatus.

Car-cab. (*Railway.*) The shelter on a locomotive for the protection of the engineer and stoker.

Car'cass. 1. (*Architecture.*) The naked shell of a house, sides and roof without floors, joiner's work, or plastering.

2. (*Shipwrighting.*) The keel, keelson, stem and stern posts, and ribs of a ship.

3. (*Ordnance.*) An incendiary projectile filled with a composition of saltpeter, sulphur, resin, turpentine, antimony, and tallow. It has three vents for the flame, and sometimes pistol-barrels arranged to discharge occasionally. It is discharged from a mortar or howitzer, and is intended to set fire to buildings, ships, or wooden defenses.

Car'cass-roof'ing. (*Carpentry.*) That which supports the covering by a grated frame of timber-work.

Car'cass-saw. A kind of *tenon-saw.* The blade is strengthened by a metallic backing, which is bent over, and closed upon it with a hammer. It has eleven teeth to the inch.

Car'cel-lamp. A lamp of French origin, in which the oil is raised to the wick by clockwork. A mechanical lamp, used in lighthouses, where the wick is overflowed with oil as a measure of equality of supply and of safety to prevent overheating of the wick and wick-tube. See MECHANICAL LAMP.

Car-couch. A chair which may be converted into a lounge for night-traveling.

A bunk or lounge in a sleeping-car, made up of two opposite seats with an intervening bridge-piece, or of a shelf let down from above.

Car-coup'ling. (*Railway.*) A device for connecting the cars in a train.

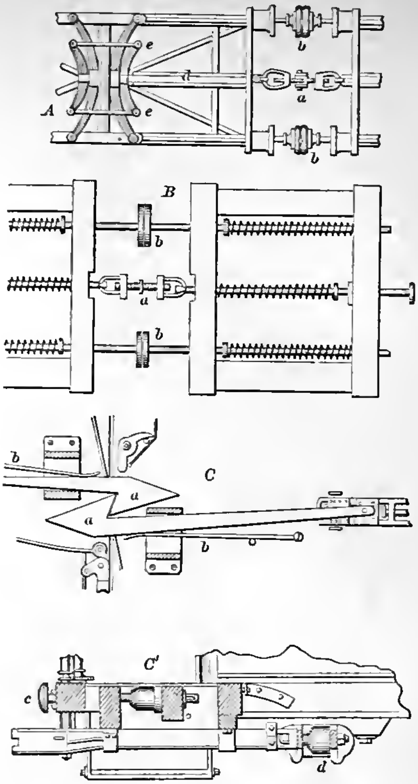
In the United States this is usually a form of shackle, but in Europe the connection is more intimate, the cars being coupled together so firmly as to prevent the jar as the cars collide or jerk apart in stopping and starting. This mode of coupling is also found in many United States railways, especially where the steam or air brakes throughout the train are operated by the engineer.

The English car-coupling (Fig. 1107, *A*) is a right and left screw-shackle, *a* on the median line making a connection sufficiently rigid to somewhat compress the *buffers b b* on each side. In some cases the *buffers* of adjoining cars are connected by chains, and their rods act as pistons in tubes provided with springs; the cars are thus coupled by the buffers. The *draw-bar d* of the coupling is connected to an elliptic spring *e*, which diminishes the jerk of the cars when starting the train.

Some of these features are also found in *B*, which is an old form of United States coupling with buffers, copied from the English, from whence we early received our railway engines and cars. The drift is now the other way across the Atlantic.

C C' are respectively plan and elevation of the Miller coupling, which connects automatically as the respective point-headed hooks come in collision. A sufficient amount of lateral play is allowed to the hooks *a a* to allow the wedge-shaped surfaces to slip past each other, and springs *b b* at the rear of each keep them in engagement when once connected. Special means are used to withdraw the hooks from each other when they are to be uncoupled. The

Fig. 1107.



Car-Couplings.

lower view, *C'*, shows the mode of engagement less clearly, but exhibits also the spring buffers *c*, above the hooks, which act as fenders to the cars, and deaden the blow as the cars surge against each other in checking the speed of the train. The coupling-hooks themselves have also springs *d* for the same purpose.

In Fig. 1108, *D* is a falling latch-hook.

E has a gravitating hook *a*, with a spring which allows it to yield to the thrust of the entering link *b* in the act of coupling. On the back of the hook *a* is a handle *c*, which is lifted to uncouple the link.

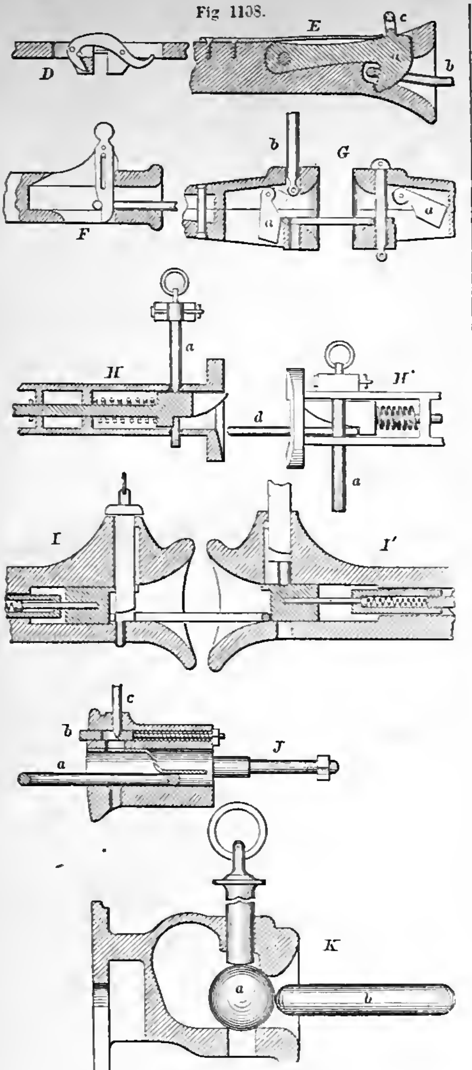
F has a vertically sliding bolt, which rises automatically as the link collides with its lower inclined portion when coupling, and then falls down into engagement.

G shows a pair of draw-heads in which the tumbling-latch *a* holds up the pin until thrust back by the entering link. The pin *b*, when fixed for automatic coupling, rests on the toe of the latch, as in the left-hand draw-head; the link pushes back the latch and allows the pin to drop from the toe, as in the right draw-head.

H H' are two draw-heads, showing the respective positions of the uncoupled and coupled pins *a a*. In the former, the left of the figure, the pin *a* rests on a sliding latch, which will give way before the thrust of the link *d*,— a result already accomplished in *H'*, the right-hand figure.

I I' are two matching draw-heads, corresponding in essential respects with the one just described; sliding pistons holding up the link and retiring before the thrust of the entering link.

Fig. 1108.



Car-Couplings.

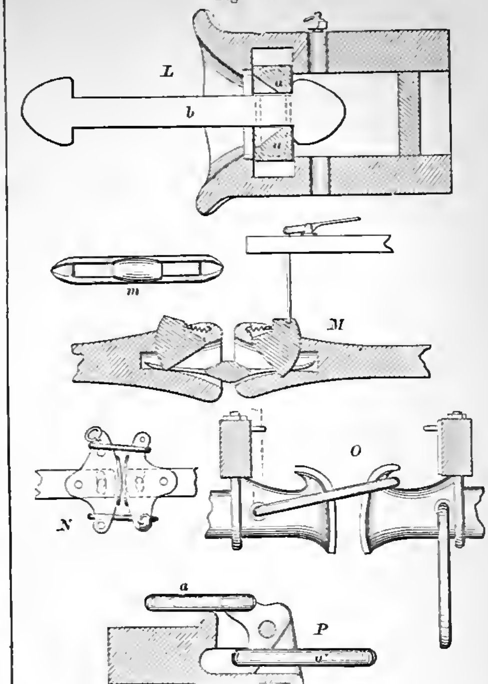
J has a double feature. A plate to hold the projecting link *a* in coupling position, and a small sliding-latch *b* above, to hold the coupling-pin *c*, which is dropped, when the draw-heads come into actual collision and thrust in the latch.

K has a ball *a*, which holds up the pin, and rolls away before the thrust of the link *b*, allowing the pin to drop.

In Fig. 1109 *L* has the arrow-head bolt *b*, which is a substitute for the usual link, and is grasped between the pair of jaws *a a*, which spring apart to receive it. The arrow-head form of coupling has many variations, which principally concern the modes of retention.

M has a bar with two slots instead of two heads, the bar being shown separately at *m*. As the end of the bar *m* enters the draw-head, it thrusts up the gravitating-latch, which immediately falls into the slot of the bar. To uncouple the link, the latch is lifted by a lever above.

Fig. 1109.



Car-Couplings.

N is a plan view of a coupling in which each draw-head has a link which couples over a horn on the corresponding draw-head of the other car. A pin in each case prevents accidental disengagement.

O is an elevation of a pair of draw-heads, each of which has a link which may be coupled over a horn on the other.

P has a two-horned tumbler, one of which carries a link *a* which may be the means of coupling to a corresponding draw-head, and the other forms a latch for a link *a′* proceeding from the other draw-head.

KENDALL'S English patent, April 17, 1841, describes an elastic coupling which retains its hold while the pull is direct, and becomes detached when the pull is oblique, by reason of one of the carriages leaving the track. This feature has formed the subject of many United States patents.

Card. 1. (*Cotton and Wool Manufacture.*) *a.* An instrument for combing wool, flax, or cotton, to disentangle or tear apart the tussocks and lay the fibers parallel in order for spinning.

The work is analogous in some of its effects to that of hackling, in which flax for the distaff is brought into a condition for being drawn out by the hand, in the old modes of spinning. With cards and in the carding-machine shorter fiber is operated upon than in the case of hemp or long flax, of which a hank is taken and switched down upon the teeth of the hackle.

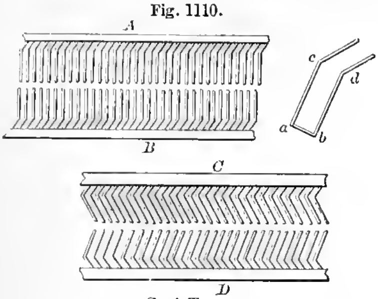
A *card* is a wire brush in which the teeth are inserted obliquely through a piece of leather, or of cotton, linen, or india-rubber, which is then nailed to a wooden back.

With hand-cards, they were operated by drawing them past each other, so as to disentangle the bunches of fiber and lay the filaments straight. A similar effect is produced in the carding-machine (which see), but the opposing cards are upon a large revolving-cylinder, and a number of circumjacent wire rollers and flat cards.

The leather or other material to be furnished with *teeth* is pierced with numerous holes, in which are fixed bent pieces of hard drawn wire called *dents* or *teeth*.

Each piece is first bent at right angles at *a* and *b*, and afterwards a second bend at *c d*, at an obtuse angle, which must be invariable for the same set of

Fig. 1110.



Card-Teeth.

cards. Strict uniformity is necessary as to the size, shape, obliquity, and length of the teeth, and also in the angle which they bear to the cylindrical surface around which they are placed.

The action of the cards is as follows : —

If the two cards *A* and *B* be moved in opposite directions with a tangled tuft of cotton-wool between them, the fibers will be seized by all the teeth, one card pulling them one way and the other pulling them the other, until, by repeated applications of the cards, the fibers are disentangled and laid in parallel lines, each card taking up and retaining a portion of the cotton. All the cotton may be gathered on one card by reversing the position of the two and placing them as when, by drawing the upper card *C* over the lower one *D*, the teeth of the lower one offer no resistance, but give up their cotton to the upper card.

Just as by the persistence of application of the hand-card the bunch of cotton is at last reduced to order, so in the carding-machine the operation is repeated between a central carded cylinder, and several carded rollers and flat cards, so arranged as to return imperfectly reduced knots again and again to the main cylinder. See CARDING-MACHINE.

Cards are distinguished by quality, the form of the backing, or position ; as, —

Sheet-card or *card-sheet*.

Fillet-card, in form of a ribbon.

Breaking-card. *Finishing-card*.

Top-card ; top-flat.

b. A *sliver* of fiber from a carding-machine.

Cardings or *rolls* are delivered of the length of the card-roller, the *clothing* on which is in longitudinal strips. See ROLLER-BOWL ; CARDING.

2. (*Menage*.) A currying-tool formed of a piece of card-clothing mounted on a back with a handle, and used as a substitute for a curry-comb.

3. (*Weaving*.) One of the perforated pasteboards or sheet-metal plates in the Jacquard attachment to looms for weaving figured fabrics. Each perforation represents a warp-thread which is to be lifted, and there are as many cards as there are weft-theads in a single occurrence of the pattern. The cards are presented consecutively by a revolving perforated bar. See JACQUARD LOOM.

4. (*Nautical*.) (From *cardinal*.) The dial or face of the mariner's compass, in which the needle and dial rotate together.

"Reason the card, but passion is the gale." — POPE.

It is marked with the compass-points. These points or rhumbs are 32 in number ; the angle comprehended between two points is 11° 15'.

5. A pasteboard. A thick paper sheet made up of several layers.

6. A pasteboard cut to a size and marked for a game. The playing-cards are in four suits of thirteen each.

Cards are colored by stenciling, an art older in Europe than that of printing by relief-blocks. The common cards of one color, red or black, are called *pips;* the court cards, of many colors, are *têtes*. The art of stenciling as a mode of laying out ornamental designs for carving, frescoing, and repetitive ornamentation is very ancient.

Chatto, in his "Origin and History of Playing-Cards," London, 1848, says that the earliest playing-cards which he has had an opportunity of examining were evidently stenciled, and of the date of 1440. Stenciling cards was quite a business at Nuremberg, 1433–77, as appears by the town books. Chatto regards cards as an Eastern invention, and supposes that they became known in Europe as a popular game between 1360 and 1390. Covelluzzo, an Italian chronicler of the fifteenth century, says they were brought to Viterbo in 1379. Charles VI. used them 1393, and thereafter laws and commercial notices and restrictions give evidence that they were very common.

"There is a great deal of time lost in playing cards," said a moralizing gentleman. "Yes," said a lady devotee, "in shuffling and cutting. But then, how is it to be avoided ?" Lady Spencer may have been one of the parties conversing, and Mark Isambard Brunel, the philosopher, another. This talented mechanician, at all events, did invent a machine for shuffling and cutting playing-cards without the aid of the fingers, and did so at a playful request of Lady Spencer.

Mr. Brunel's talent was most versatile. He constructed the Thames Tunnel ; the block-making machinery of the Portsmouth (England) Dockyard ; a theater in New York ; a canal in New York State ; the harbor defenses of New York ; veneer-saws ; shoe-making machinery ; nail-making machines ; paper-ruling machines ; machines for twisting, measuring, and forming sewing-cotton into hanks ; a hydraulic packing-press ; improvements in suspension bridges, building arches without centering, steamboats, gas-engines, etc. His son, Isambard Kingdom Brunel, was the engineer of the Great Western Railway, of England, and the designer of the Great Eastern steam-ship.

Cards are interesting in the history of the arts as being among the earliest subjects of the printing process. See PRINTING.

With the games this work has nothing to do, and perhaps, but for M. I. Brunel, the subject would not have been referred to here.

A good article on the subject of cards and dice may be consulted in Harper's Magazine, Vol. XXVI., pp. 163–176.

Card'board. Cardboard is produced by pasting a number of sheets of paper together. Bristol board is all white paper, and is made of two or more sheets according to the thickness required. Other qualities are made by inclosing common thick paper between sheets of white or colored papers of the required quality.

A surface of paste is given between the contacting surfaces of the outside paper and the filling, and a pack of pasted *boards* are subjected to a heavy pressure, which squeezes out the water. The cardboards are then hung up in pairs to dry, and in 24 hours are ready for the press, which renders them perfectly smooth and polished.

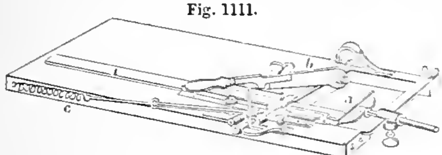
The cardboards are made up into a pack alternately with polished copper plates, and the pack is passed between a pair of rolls under heavy pressure. This removes all inequalities, wrinkles, and protuberances, the result being a highly polished glazed surface.

Card'board-press. A press having a pair of rolls adapted to be closed together with great force, and used to smooth and polish sheets of card passed there-through.

Card-cloth'ing. The garniture of a carding-machine.

Card-cut'ter. A machine for reducing cardboard to pieces of uniform and proper size for cards.

Fig. 1111.

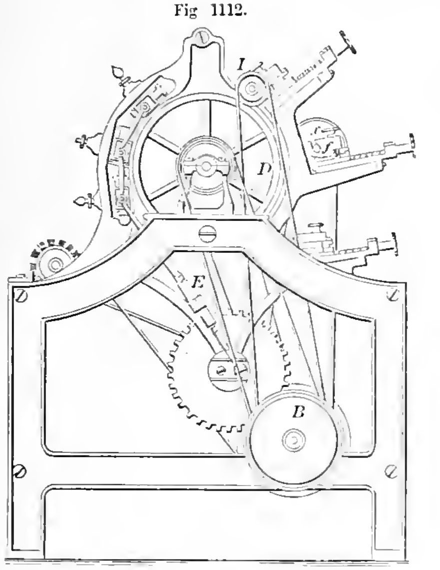


Card-Cutter.

In that shown, the paper is held by the adjustable gage-clamp *a*, and is cut by the knife *b*, which is elevated by the spring *c* and connections, and depressed by hand.

Card Grind'ing-ma-chine'. A machine having a rotary emery-wheel *D* revolving in a central position relatively to the *flats* and card cylinders, which are arranged around it. The grinding emery-wheel has longitudinal reciprocation on its slotted

Fig 1112.



Card-Grinder.

shaft by an inclosed screw therein, and grinds simultaneously two or more top flats and two or more *workers, strippers*, or *licker-in* cylinders. Each top flat reciprocates in a guide tangential to the wheel by a connecting-rod *E* to a crank-pin. The bearings *f* for the ends of the flats and of the cylinders, as at *x*, are adjustable radially to the grinding-shaft. The cylinders are rotated on their axes by bands from pulley *B* on the lower shaft, reaching to the pulleys on the cylinder-shafts, as at *I*.

Card'ing. A roll of wool as it comes from the carding-machine. The *doffing-cylinder* has longitudinal bands of cards, the wool on which is removed by the *doffing-knife* in the form of separate *slivers*, the length of the doffing-cylinder. These slivers fall into a *roller-bowl*, which gives them a slight rolling and compacts them into *cardings*. These have but little strength, as their fibers are only held together by being interlaced. They next receive a slight twist in the *slubbing-machine*.

Card'ing-ma-chine'. (*Fiber.*) A machine consisting of a congeries of toothed cylinders for drawing out and placing in parallel line the fibers of wool, cotton, or other staple.

The hand-card, which preceded the carding-machine, consisted of two brushes furnished with short, slanting, wire teeth, which all pointed in one direction. The wires were passed through leather, and the leather was nailed to a board. The brushes were grasped, one in each hand, and drawn past each other, so laying straight the fiber which was placed between them. The action is explained under CARD (which see).

In 1748, Lewis Paul patented two different machines for carding. In one of them the cards are arranged on a flat surface, and in the other they are arranged on the periphery of a drum. From what cause we know not, the invention seemed to have no repute or success at the time, but came out again twelve years afterward as the invention of Hargreaves, under the auspices of Robert Peel, of Bamber Bridge, the grandfather of the statesman, Sir Robert Peel. Hargreaves fixed one of the cards in a block of wood, and the other was slung from hooks fixed in a beam. The hooks remained in the kitchen at "Peel Fold" in 1850, but the cards were destroyed by a mob who came from Blackburn, — a part of the same wretched story of ignorant men opposing the introduction of machinery.

The same Robert Peel, or his son of the same name and the father of the statesman, employed Hargreaves in 1762 to erect the cylinder carding-machines in a mill at Blackburn.

Though the carding-machine was well and efficiently constructed in the time of Arkwright, it was not till after several attempts by different men, Paul, Hargreaves, and Arkwright, worked in such a manner that it is difficult now to determine what share each had in the matter. It was not till twenty years after Paul's invention that the cylinder carding-machine came into extensive use; and even then it performed intermittingly, and did not yield a continuous sliver.

The cards were arranged on the surface of the drum, parallel to its axis, a space being left between each. The cotton-wool was put on by hand, and when the cards were full the machine was stopped, the cardings taken off separately by a movable comb, the spaces between the cards regulating the substance of each carding. The cardings were then joined end to end, to make a continuous sliver. A more systematic and equable mode of feeding was adopted when a weighed quantity of cotton was made to cover a certain area of the travelling feed-apron, which moved at an even rate towards the throat of the machine.

Arkwright invented the plan, yet in use in some cases, of rolling up the feeder with the cotton spread upon it, and allowing it gradually to unroll to feed the cylinder.

Another improvement was to obtain a continuous sliver from the cylinder. This was accomplished by the *doffer*, but the next point was to get it from the *doffer*. After many experiments, it appears that Arkwright hit upon the plan which is in use to the present time, the *crank* and *comb*. It is fair to say, however, that the invention is also claimed for Hargreaves. There seems to have been a rivalry of feeling between the two men, who were each highly meritorious, and we are much indebted to both. It is stated that Hargreaves obtained a sketch of it from one of Arkwright's men. Not likely; Hargreaves seems to have been made of better stuff.

The comb is a plate of metal toothed at the edge, and, reciprocating perpendicularly, detached the fleece from the teeth by slight reiterated strokes.

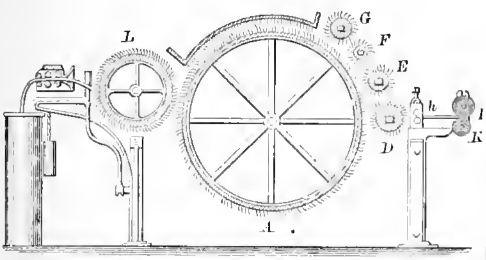
The action of the machine is substantially similar to that of the hand-cards, so far as the functional character is concerned; but it enables a number of cards to act upon a continuous *lap* and deliver continuous *slivers*.

The machine has a horizontal cylinder, whose entire circumference is covered with narrow fillet-cards wound spirally around it, a blank space intervening between each fillet, or is covered with strips lengthwise of the cylinder. The cylinder revolves beneath a concave shell, whose face is also lined with cards, and the teeth of each act coincidently upon the bunches of fiber to draw them apart and lay the individual fibers parallel, as explained under CARD.

The first carding-machines built in America were made for Mr. Orr, of East Bridgewater, Mass., in 1786.

The carding-machine consists of a number of rollers and drums, and one large cylinder all clothed

Fig. 1113.



Carding-Machine.

with *cards*, which are so arranged as to feed, card, doff, and deliver. A portion of the circumference of the large cylinder *A* is inclosed by smaller toothed rollers *D E F G*; then succeed wooden slats lying lengthwise of the cylinder, and supported by the side at such distance as to allow the wire teeth to come into the required proximity. These slats are called *card-tops*, *top-cards*, or *top-flats*. Beyond the flats is a toothed drum *L*, called a *doffer*, from whence the fleece is removed by the *doffing-knife*; the wide ribbon is then gathered in a thimble, consolidated by iron rollers, and delivered into a can.

The operation is as follows: —

The lap-cylinder is placed in the bearings *I*, and rests on the roller *K*; the end *h* of the lap is brought to the rollers by which it is presented to the toothed drum *D*, which draws the cotton into the machine, and is called the *licker-in*. The filaments thus torn from the end of the lap are immediately seized by the large cylinder *A*, which revolves at a much higher speed, and are teased out by the teeth of the second roller *E*, which moves more slowly than *D*, and picks the knots off the cylinder. These knots are carried round by *E* and are caught by *D*, which presents them again to *E* along with fresh material from the lap. This is the first round which the knots take, but several more are in store for them if they are obdurate or if they escape the first attack.

The tufts or knots which pass the first pair of rollers *D E* are arrested by the fourth roller *G*, which is placed closer to the cylinder *A*, and moves with the same speed as *E*. The knots caught by *G* are teased out by *F*, and returned to the cylinder *A*, and may be again caught by *G*, if they exist.

Passing the combination of rollers, the fibers are next brought into contact with the cards of the *top flats*, which arrest knots and hold them till the entanglement is removed, or till the flat is taken out and cleaned, which is occasionally done.

After all these obstacles have been passed, the filaments lie in parallel rows among the teeth of the cylinder card, and are removed therefrom by the *doffer L*, which is covered with a spiral fillet of cards, revolving at a much slower rate than the cylinder and in a different direction. The fine fleece thus stripped from the cylinder by the *doffer* is removed from the latter by a vertically reciprocating comb, called the *doffer-knife*, which has a rapid vertical motion tangentially to the points of the teeth. A fine fleece the whole length of the cylinder is thus obtained, and is gathered up into a ribbon, and passed in at the funnel, whence it passes to three consecutive pairs of condensing rollers, which, revolving at a relatively greater velocity as the sliver proceeds, slightly draw it, and tend to parallelize the fibers. It thence passes as a light, downy, coherent sliver into the can, in which it is transported to the *throstle*, *doubler*, or *bobbin and fly frame*, as the case may be.

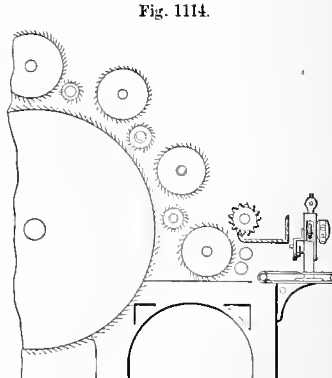
For fine spinning, the operation is repeated, the first machine being called a *breaker-card* and the second a *finishing-card*.

For the preparation of fine yarns, the cards have closer set wires than is necessary for ordinary or coarse work.

The carding-machine as just described is particularly adapted for cotton, but does not differ materially from the wool-carding machine.

There are some adjuncts to the latter, however, which have no place in the cotton-carding machines. Among these are the devices for oiling wool, which is necessary to keep the fibers loose and prevent their becoming felted.

Fig. 1114.



Wool-Oiling Attachment.

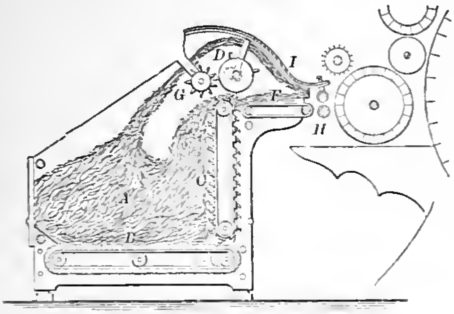
The *wool-oiling machinery for carding-machines* has a dripping oil-tank which has a transverse and rotary motion above the feed-apron of the machine, so as to drop oil upon the wool as it proceeds towards the card.

The transverse motion is given by a crank and pitman, and the reciprocating rotary by a toothed wheel acting against the edge of the trough.

The wool carding-machine has a large cylinder surmounted by smaller ones called *urchins*, which work in pairs, and are called *workers* and *cleaners*. These act in succession to remove knots and tangles from the main drum, and return the fiber to the latter again to undergo the action of the next set, if still obdurate.

In the feeder shown in Fig. 1115, the material thrown into the box *A* is carried forward and upward by the aprons *B C F* to the feed-rolls *H*. *G* is a

Fig. 1115.



Carding-Machine Feeder.

picker-roll, which serves to prevent the fan *D* from becoming fouled, and also to prevent flocks of wool from passing unopened between the plate *I* and apron *F*. The fan *D* blows the wool into the passage *F*, whence it passes to the carding-machine.

The various rollers in a carding-machine are known by names which indicate their functions, — or perhaps we may say appearance, in one case.

Feeding-rollers.	Urchins.
Distributing-rollers.	Clearers.
Workers.	Doffers.
Strippers.	Fly-rollers.

The material which went in as a *lap* comes out as a *fleece* or as *slivers*.

Car'do. A pivot and socket; an apparatus by means of which the doors of the ancients were fixed in their places, and made to revolve in opening and shutting.

Car-door Lock. For railway-cars; one with a latch opened by a key from either side.

Card-press. (*Printing.*) A small press adapted for printing cards, etc. A preferred form has an inclined bed, for convenience of feeding; the impression is given by a cam, and is regulated by means of platen screws. The press has adjustable feed-guides, a large distributing-cylinder, two inking-rollers, a card rack and receiver, and is capable of making from 1,000 to 2,000 impressions per hour.

Card-set'ting Ma-chine'. A machine for setting the bent wire teeth (*dents*) in the bands or fillets of leather, or alternate layers of cotton, linen, and india-rubber, which form the backing of the wire brush of the carding-machine.

For the card-setting machine the leather is first prepared by a planing-machine, which cuts it into fillets, which are then stretched and pared to an even thickness. This is wound upon a roller and fed to the machine, where it is held by a clamp while the wires are inserted. These are contained in a drum at the side. Two prickers advance and make holes through the leather; a pair of sliding pinchers seize the wire, and wind off from the drum a length sufficient for a tooth; a steel tongue holds this piece by the middle while it is cut off. Steel fingers bend it, and carry it forward to the holes made by the prickers. Pinchers on the opposite side of the leather seize the wires, and a bar rises up and bends the two limbs so as to form a knee in each. A pusher at the back then sinks the bight of the wire into the leather, which is then shifted by the guide-rollers, and the process is repeated. The cards are finished and made true by grinding. (See CARD-GRINDING MACHINE.) These wire brushes are termed cards, and such fillets form the *clothing* of the drums, cylinders, or strips to which they are fastened.

Ca-reen'ing. (*Nautical.*) The operation of exposing a part of a ship's bottom by a purchase applied to the masts to tilt them laterally from the perpendicular. It was careening that upset the "Royal George" in 1782 at Spithead: —

> .... "They
> Had made the vessel heel,
> And laid her on her side."

Ca'ret. (*Printing.*) A mark ("∧") indicating an insertion; interlinear or marginal.

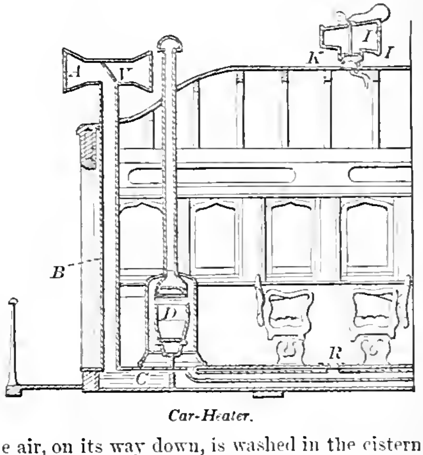
Car'go-jack. (*Nautical.*) An implement like a lifting-jack, but sometimes used upon its side for stowing heavy cargo.

Car'go-port. (*Nautical.*) An opening in the side of vessels having two or more decks, through which the lading is received and delivered. It is closed by a shutter; and made water-tight before proceeding to sea.

Car-heat'er. An arrangement for warming a railway-car. A stove or a system of pipes from one heater, which communicates in turn with each of the cars in the train.

In Fig. 1116 is shown the end of a car in which is a stove *D* inclosed in an air-heating chamber. *A* is a hood with a swinging valve *V*, the latter being placed in such position as to direct the air downward by pipe *B* in whichever way the car may be moving.

Fig. 1116.



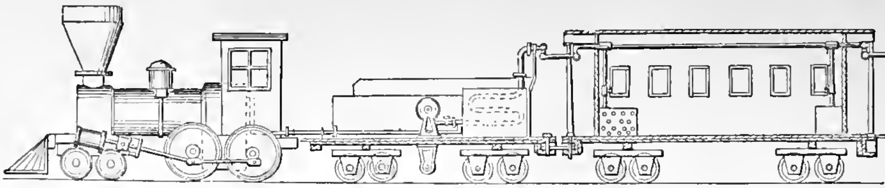
Car-Heater.

The air, on its way down, is washed in the cistern *C*, and, after heating in the chamber around the stove, is conducted by pipes beneath the floor, and escapes at registers *R* into the saloon. The outward current is induced by an adjustable cowl *I I K*, which is set with its flaring mouth towards the rear of the car for the time being.

Fig. 1117 shows an arrangement in which the cars of the train are heated by steam from the locomotive, or by heated air; pipe-couplings between the cars being the means of connecting the system of pipes and radiators of the respective cars.

When the cars are in motion, the steam-pipe is

Fig. 1117.



Car-Heater.

closed, or nearly so, and the fan set in operation to force air through the furnace-pipe and register into the different cars. The air may be moistened by the admission of a small amount of steam. In case of a detention of the cars, the air-pipe near the fan is closed by a valve, the other air-valves are closed, and, the steam-valve being opened, steam is forced through the coil in the heater and into the radiators.

Another form for heating street-cars is a stove beneath the bed and registers in the floor, or hot-air distributing-pipes throughout the car.

Car'il-lon. (*Music.*) A chime of bells, originally consisting of four, and played by keys. See CHIME.

One form of carillon machinery has barrels with pins, which first effect the elevation of the hammer and then deliver the blow; but, by an improvement, the work of the pins is confined to releasing detents and causing the hammer to strike the bell, simultaneously throwing forward a spring finger in the path of peculiar cam-wheels, continuously revolving, which thereby immediately elevate the hammer again into the striking position.

Car-in'di-ca'tor. A registering device operated by a revolving wheel or axle of the car, to indicate the distance run. In one case, the indicator is operated partly by clock-work and partly by the revolving wheel or axle of the street-railway car to which it is applied. It determines at the end of a trip whether the car has been running regularly, and, if not, at what points on the road improper stoppages have been made, or where the speed of the car has been increased or retarded.

Car'i-ole. (*Vehicle.*) *a.* A small, open carriage.

b. A covered cart.

c. A kind of calash.

Car-jack. (*Railway.*) A powerful form of screw-jack by which a car or locomotive is lifted, to replace it on the track, to run a truck beneath, or for other purpose in the shop or on the road.

The hydraulic-jack is the more efficient implement, and is now made in very compact, portable, and powerful form. See HYDRAULIC-JACK.

Car-lamp. One for lighting the inside of a railway-car at night or in tunnels. Candles are frequently employed in the place of oil, to avoid the danger of adding fire to the other disasters in case of the overturning of the car.

In street cars the lamps are frequently made to illuminate a sign, which indicates to pedestrians the destination of the car; or a colored glass may indicate to habitual patrons the same thing.

Car-lan'tern. One adapted to be carried on the arm, to leave both hands free. See LANTERN.

A signal-lamp indicating destination, raised above the roof of the car.

Car'let. A three-square, *single-cut* file, or *float*, used by comb-makers. See COMB.

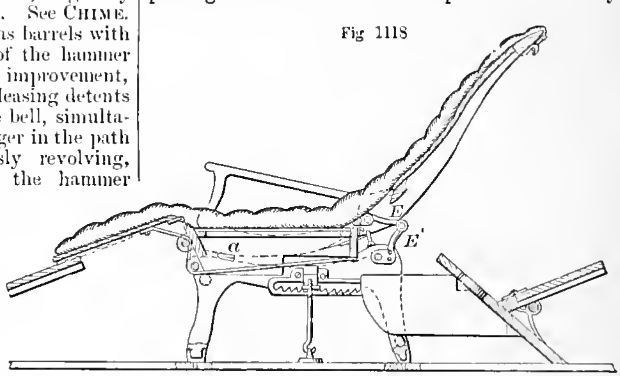
Car'ling. (*Shipbuilding.*) One of the longitudinal beams which are framed into the transverse deck-beams and aid in trussing the frame of the ship.

The *coamings* of a hatchway are bolted to the top of the *carlings*, and the *head-ledges* to the top of the *beams*.

Car'ling-knee. (*Shipbuilding.*) A knee in a ship lying across from the sides to the hatchway beneath the deck.

Car-lounge. A car-seat or sleeping-chair, so contrived as to assume a reclining position when desired. The illustration shows the lounge of one passenger and the foot-rest of the person immediately behind him. The body of the seat is hinged at *a* to the frame, and the more or less reclining position is obtained by means of the knuckle-joint *E E'*. The foot-rest is an extension piece, which is projected when needed; the motions of the back and leg-rest are coincident.

Fig. 1118.



Car-Lounge.

Ca-roche'. (*Vehicle.*) A kind of two-wheeled pleasure-carriage.

Car'ol. (*Building.*) A seat fitted within the opening for a window; a *bay-stall*. *Caroll; carrol.*

Car'pen-ter's Chis'el. Chisels for wood-workers' use are made of moderately hard steel, have one plane and one beveled edge, and are divided into *firmer* and *framing* or mortise chisels.

The former have a tang inserted into the handle, the lower end of which rests against a flange on the stem, while in some of the latter the handle is inserted into a socket at the upper part of the stem.

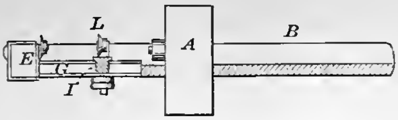
Joiner's and *paring* chisels are names of grades, rather than of kinds. See CHISEL.

Car'pen-ter's Clamp. A frame in which work such as doors, sashes, shutters, etc., is forced up into place, and held while being nailed or pinned.

A kind of vise for grasping several parts and holding them while the glue sets, or for other purposes.

Car'pen-ter's Gage. A scribing-tool for depth or width, according to construction and uses. It commonly has a point projecting from the shank *B*, and a movable head or fence *A*, which is adjusted for distance from the point, and secured by a set-

Fig. 1119.



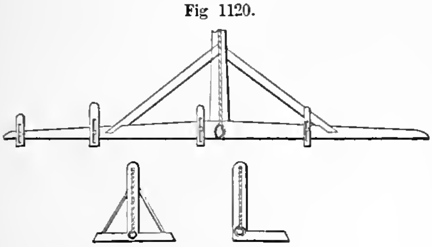
Carpenter's Gage.

screw. In the example, revolving rollers with sharp edges are used instead of marking points, and the roller *L* is adjustable towards and from the roller *E* for making two parallel scribes at a determinate distance from the fence *A*.

Car'pen-ter's Lev'el. An implement for determining horizontality and verticality.

It has a base piece, standard, and plumb-line, and

Fig 1120.



Carpenter's Levels.

is used by builders and road-makers in testing surfaces, to ascertain whether they are level.

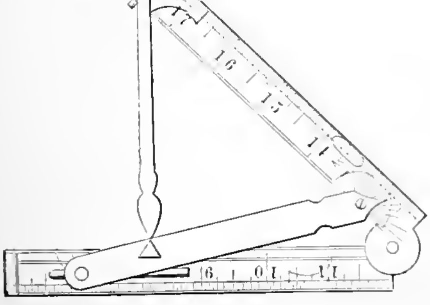
The feet may be so adjusted, to suit the required grade or pitch, that the level becomes a means of determining a slope.

Car'pen-ter's Plane. Carpenter's planes are of various descriptions, adapted to the different kinds of work they are intended to perform, — as, the jack-plane, for rough-dressing a surface; the smoothing-plane, for finishing it off; and grooving and molding planes, some of which have special names, for making grooves or elevations of various forms. See Plane.

Car'pen-ter's Plow. A plane for making a groove in the edge of a board, to be occupied by the matching tongue of another board, or by the edge of a panel.

Car'pen-ter's Rule. Ordinarily, a two-foot rule, jointed in the middle and divided to eighths or sixteenths of an inch.

Fig. 1121.



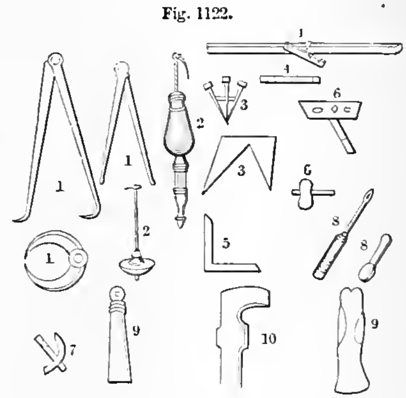
Carpenter's Rule.

That shown in the figure has a pointed swinging arm, and also a curved scale and pointed index, so that the instrument may serve the purposes of a level, square, and bevel, any angle of inclination being noted by the pointer upon said scale.

Car'pen-ter's Square. An L-shaped steel rule having two arms meeting at a right angle, and graduated to feet, inches, and fractions. It is used by carpenters and other mechanics for laying off perpendiculars to a line or surface, and setting off the distances thereon at the same time. See Try-square.

Car'pen-ter's Tools. In the reign of Henry II. of England, the whole stock of a carpenter's

Fig. 1122.



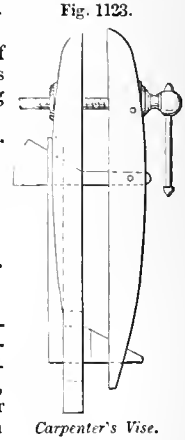
Roman Tools.

tools was valued at one shilling, and consisted of a broadaxe, an adze, a square, and a spoke-shave. The number has largely increased since. See specific index, Wood-working.

Fig. 1122 shows a variety of old Roman implements of this kind, as represented on existing monuments.

1 1 1, compasses and calipers.
2 2, plumb-bobs.
3 3 5, templet and squares.
4 4, single and jointed rules.
6 6, mallets.
7, adze.
8 8, scriber and soldering-tool.
9 9, chisels.
10, hatchet.

Fig. 1123.



Carpenter's Vise.

Car'pen-ter's Vise. A device with a stationary jaw attached to the bench, and a movable jaw operated by a screw, used for clamping a board or timber while being operated on by the plane or chisel.

Car'pen-try. See under the following heads:—

Abat-jour.
Abat-voix.
Abutment.
Accouplement.
Ajambe.
Ambe.
Angle-bar.
Angle-tier.
Ante-venno.
Apron.
Apron-piece.
Arched-beam roof.
Architrave.
Arris.
Arris-fillet.
Arris-gutter.
Ashlering.
Astragal.
Attic.
Awning.
Badigeon.
Balk.
Baluster.
Barge-board.

Barge-couple.
Base.
Batten.
Bay.
Bead.
Bead and butt work.
Bead and quirk.
Bead, butt, and square work.
Beaking-joint.
Beam.
Bearer.
Bench-vise.
Bent.
Bevel.
Binder.
Binding-joist.
Binding-rafter.
Bird's-mouth.
Blind.
Blocking.
Bolection.
Bolster.
Box-frame.
Box-girder.
Boxing.
Brace.
Bracket.
Breast-summer.
Bridge-board.
Bridging-joist.
Bridging-piece.
Brob.
Brog.
Brow-post.
Built-beam.
Built-rib.
Butment-cheeks.
Button.
Cage.
Caisson.
Camber-beam.
Camp-ceiling.
Cantilever.
Carcass.
Carcass-roofing.
Carpenter's clamp.
Carpenter's square.
Carpenter's tools.
Carriage.
Carriage-piece.
Cartouch.
Case-bay.
Casemate.
Casement.
Cavetto.
Ceiling.
Ceiling-joist.
Chain-timber.
Chalk-line.
Chantlate.
Chevron-molding.
Clamp.
Clamp-screw.
Clapboard.
Cleading.
Clear-stuff.
Coak.
Cocket-centering.
Cocking.
Cockle-stairs.
Coffer.
Collar-beam.
Compass-window.
Corbel.
Cornice.
Couples.
Coved-ceiling.
Cradle.
Crenelated molding.
Cribbing.
Cripple-timbers.
Cross-beam.
Crown-post.
Culver-tail.
Curb-beam.
Curb-plate.
Curb-roof.
Curtail-step.
Current.
Cushion-rafter.
Dado.
Dais.
Deadening.
Deal.
Dental cut.
Diagonal.
Dimension-lumber.
Dished-out.
Dog-leg stairs.
Dome.
Door.
Door-case.
Door-step.
Door-strip.
Dorman-tree.
Dormer.
Dovetail.
Dragon-beam.
Draw-bore.
Dwarf-rafter.
Eave.
Eave-board.
Eave-trough.
Estrade.
False rail.
False roof.
Faying out.
Feather-edged.
Femerell.
Fender-beam.
Filling-in pieces.
Fishing.
Flap.
Flight.
Flitch.
Floor.
Floor-clamp.
Fox-tail wedging.
Frame.
Franking.
French-roof.
French-window.
Fret-work.
Fuor.
Furring.
Gable.
Gage.
Gain.
Gambrel-roof.
Garret.
Geometric staircase.
Girder.
Grafting.
Ground-plate.
Grounds.
Ground-sill.
Gutter.
Half timbered.
Halving.
Hammer beam-roof.
Hand-rail.
Hatchet.
Heading-course.
Heading-joint.
Heel-post.
Herring-bone.
High roof.
Hip.
Hip-knob.
Hip-rafter.
Hip-roof.
Hoarding.
Hollow newel.
Housing.
Impages.
Inter-ties.
Interligneum.
Jack-timber.
Jalousie.
Jamb.
Jib-door.
Joggle-post.
Joist.
Jut-window.
Key.
King-post.
King-truss.
Knee.
Ladder.
Lagging.
Laminated-rib.
Landing.
Lath.
Lathing-clamp.
Lattice.
Leaf.
Lean-to.
Ledge.
Ledger.
Level.
Line-winder.
Lining.
Lintel.
Listing.
Luffer (Louvre).
Lumber.
Main-couple.
Mallet.
Mansard-roof.
Match-boarding.
Mitered border.
Molding.
Mopboard.
Mortise.
M-roof.
Mud-sill.
Muntin.
Needle-beam.
Newel.
Nogging.
Norma.
Nosing.
Notch-board.
Notching.
Pale.
Panel.
Partition.
Pitch.
Pitching-piece.
Plane.
Plugging.
Plumb.
Plummet.
Pole-plate.
Post.
Prick-post.
Principal.
Pugging.
Punch.
Puncheon.
Purlin.
Quarters.
Queen-post.
Quirk.
Rabbet.
Rafter.
Raising-plate.
Ramp.
Reason-piece.
Reglet.
Relish.
Reveal.
Riser.
Roll and fillet.
Roof.
Rule.
Run.
Sarking.
Sash.
Sash-frame.
Scaffold.
Scaffold-bracket.
Scantling.
Scarf.
Scraper.
Scribe.
Severy.
Shaker.
Shutter.
Shutting-post.
Shear-legs.
Side-plane.
Shingle.
Shook.
Shooting-board.
Shore.
Side-plane.
Sill.
Sinking.
Skirting.
Skylight.
Slab.
Sleeper.
Soffit.
Sound boarding.
Span-roof.
Splice.
Spring-beam.
Staging.
Staircase.
Stair.
Standard.
Sticking.
Stile.
Stirrup.
Stock.
Story-post.
Story-rod.
Straining-beam.
Straining-sill.
Strap.
Striking-plate.
String-board.
Stringer.
Strut.

Stub-tenon.	Trenail.
Summer.	Trestle.
Sunk coak.	Trimmer.
Sunk-panel ceiling.	Truncated roof.
Surbase.	Truss.
Swing-beam.	Trussed roof.
Syphering.	Turnpike-staircase.
Tabling.	Tusk.
Templet.	Upright.
Tenon.	Venetians.
Tension-rod.	Veranda.
Tie.	Wainscot.
Tie-beam.	Wall-plate.
Tilting-fillet.	Wane.
Tongue.	Wash-board.
Tools. Carpenter's and joiners (see WOOD-WORKING TOOLS)	Weather-boarding clamp.
	Weather-boarding gage.
	Weather-strip.
Torsal.	Well-staircase.
Trap-door.	Wind-beam.
Trellis.	Window.

Car'pet. A cloth or rug to cover a floor.

The use of rugs is of great antiquity in Egypt, India, and China; later, those of Persia and Turkey have been the more celebrated. They were anciently spread upon the ground or floor, in the tents or in apartments, and in the Orient are still small, used for sitting or reclining upon, or beneath the couches; as the Sardinian carpets, mentioned by a Grecian poet,— "Beneath the ivory feet of purple-cushioned couches."

> "Phœnicia sends us dates across the billows,
> And Carthage, carpets rich, and well-stuffed pillows."
> HERMIPPUS, quoted by Athenæus (A. D. 220).

At the supper of Iphicrates, purple carpets were spread on the floor; and at the magnificent banquet of Ptolemy Philadelphus, an account of which is given by Callixenus of Rhodes, we learn that underneath 200 golden couches "were strewed purple carpets of the finest wool, with the carpet pattern on both sides; and there were handsomely embroidered rugs, very beautifully elaborated with figures. Besides this," he adds, "thin Persian cloths covered all the center space where the guests walked, having the most accurate representations of animals embroidered on them."

The Babylonians were very skillful in weaving cloths of divers colors; we read of "a goodly Babylonish garment" as long ago as the time of Joshua, B. C. 1451, as among the spoils of Ai. The Babylonish carpets had representations of human figures and composite animals, such as winged bulls with human heads, griffins and dragons. These were numbered among the luxuries of Heliogabalus. On the tomb of Cyrus was spread a purple Babylonian carpet, and another covered the bed whereon his body was placed. These carpets were exported in considerable quantities to Greece and Rome. Researches in Pompeii show that they were used in that city in the time of Imperial Rome.

Sir J. Gardner Wilkinson gives an account of one carpet rug of Egyptian manufacture. "It is made like many cloths of the present day, with woolen threads, on linen strings. In the center is the figure of a boy in white, with a goose above, the hieroglyphic of a 'child,' upon a green ground, around which is a border composed of red and blue lines." He also mentions some fine specimens of worked worsted upon linen, now in the Turin Museum, in which the linen threads of the weft have been picked out and colored worsted sewed on the warp. These are specimens of tapestry-weaving, and resemble the present work of Persia and Turkey. The tapestry consists of woolen threads sewed on the strings of the warp by means of small shuttle-needles. The Persian carpet is formed by knotting into the warp tuft after tuft of woolen yarn, over each row of which a woof-shot is passed, the fingers being here employed instead of the shuttle-needles, as the fabric is of a coarser description. Such carpets are formed in looms of very simple construction; the warp-threads are arranged in parallel order, whether upright or horizontal, and the fabric and pattern are produced by colored threads, hand-wrought upon the warp. This may be designated the hand-wrought or needlework method, which only makes one stitch or loop at a time, in contradistinction to the machine-wrought process, the result of mechanical appliances, whereby a thousand stitches are effected at once. Herein lies the essential difference between the ancient and modern, the simple and complex, carpet-manufacture.

In Persia there are entire tribes and families whose only occupation is that of carpet-weaving. These dispose of their productions at the bazars to native merchants, who remove them to Smyrna or Constantinople, where they meet with European purchasers. The trade in real Persian carpets is, however, very limited, owing to their small size. They are seldom larger than hearth-rugs, long and narrow. Felted carpets, or *nurmuds*, are also made in Persia, but are not considered worth exporting. One specimen of carpet from Persia had tufts of worsted inserted in a felt back.

Carpets are manufactured in many of the provinces of Asiatic Turkey. In none of these places, however, does any large manufactory exist; the carpets are the work of families and households. They are woven in one piece, and there is this notable peculiarity in their manufacture, that the same pattern is never again exactly reproduced; no two carpets are quite alike. The patterns are very remarkable, and their origin is unknown even to Mussulmans. The Turkey carpet pattern represents inlaid jeweled work, which accords with Eastern tales of jewels and diamonds.

In British India the carpet manufacture is carried on extensively. At Benares and Moorshedabad are produced velvet carpets with gold embroidery. A very elaborate carpet sent from Cashmere to the London exhibition by Maharajah Goolab Singh was composed entirely of silk, and excited great admiration. In every square foot of this carpet, we are informed, there were at least 10,000 ties or knots. Silk embroidered hookah carpets, cotton carpets, or *satrunjees*, printed cotton carpets, printed floorcloth, woolen carpets, are made in different districts of British India. Of late years, linen warp has been introduced instead of cotton, and the fabric is thereby much improved. The designs of the Indian carpets have more regularity than those of Turkey, and the colors are mostly warm negatives, enlivened with brilliant hues interspersed.

Carpets were introduced into England at the time of the Crusades.

In the times of Edward VI. and Elizabeth of England the floors of palaces were strewn *daily* with rushes. This frequent change of rushes was considered to betoken an effeminacy which augured but poorly for the stability of the dynasty and the ruling families.

The walls were hung with tapestry and cloths long before the floors were carpeted. In Hampton Court Palace, built by Cardinal Wolsey, the beautiful floors are yet bare and the walls covered with tapestry.

In the Middle Ages carpets were used before the high altar and in certain parts of the chapter.

Bedside carpets are noticed in 1301, and carpets for the royal thrones in the fifteenth century.

Turkey carpets before the communion-table were used in the reigns of Edward VI., Elizabeth, and the Stuarts.

The manufacture of carpets was introduced into France from Persia, in the reign of Henry IV., about 1606; a manufactory being established at Chaillot, near Paris.

Workmen from France introduced carpet-making into England about 1750. A carpet-factory was established at Axminster, 1755, the year of the Lisbon earthquake.

There are several characteristic processes in the manufacture of carpets.

1. The web is formed of a warp and weft of flax, and the wool or worsted is inserted in tufts which are twisted around each of the warp-threads, the color of the tuft being determined by its position in the pattern. The tufts are locked in position by a shoot of the weft, the crossing of the warp, and the beating of the batten or lathe. The *Persian, Turkey*, and *Axminster* carpets are thus formed.

2. The web is formed of a warp and weft, as stated above, and the colored worsted yarns are laid along with the linen warp, and drawn into loops which project above the surface. Each yarn passes through an eyelet which depends from a cord, whereby it is drawn up to form a loop at the point where its color is required. This is the *Body-Brussels carpet*. They are usually 27 inches wide, with two threads of linen for the shoot, one above and the other below the worsted.

When the loops thus made are cut to form a nap, the carpet is known as a *pile* or *Wilton carpet*.

3. Tapestry Brussels differs from regular or body Brussels in being woven in a common loom and printed in the warp.

4. Tapestry velvet or patent velvet differs only from tapestry in being cut like Wilton.

5. The carpet is formed by an amplification of the ordinary weaving-processes; two or three webs being woven at the same time, the warps being interchangeable and being brought to the surface according to the color required, and forming two-ply carpet or three-ply carpet, respectively. The carpet is woven by a *figure-work* or ordinary loom, with some peculiarities, such as the exposure of the weft (*Ingrain*), the warp (*Venetian*), or a peculiar weft (*Chenille*).

6. The carpet is formed of a body of fibers felted together with a fabric without spinning or weaving. The product is generally printed, and forms *drugget*.

7. The carpet is woven in plain colors and afterwards printed.

8. The carpet is dyed in party-colors, nicely adjusted so as to fall into their right places when woven into a fabric.

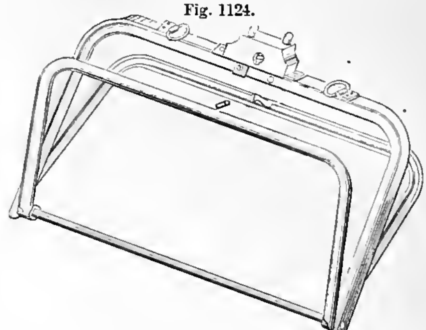
9. A pile is cemented to a backing-fabric. See Cemented-back carpet.

For the varieties of carpets see the following: —

Axminster carpet.	Ingrain carpet.
Brussels carpet.	Kidderminster carpet.
Cemented-back carpet.	Persian carpet.
Chenille carpet.	Pile carpet.
Damask carpet.	Printed carpet.
Drugget.	Rag carpet.
Felt carpet.	Rug.
Scotch carpet.	Two-ply carpet.
Tapestry carpet.	Velvet-pile carpet.
Three-ply carpet.	Venetian carpet.
Triple-ingrain carpet.	Wilton carpet.
Turkey carpet.	

Car'pet-bag Frame. The iron frame which distends the cloth covering of a traveling-bag or satchel. The two jaws are pivoted to the hinge-rod

Fig. 1124.

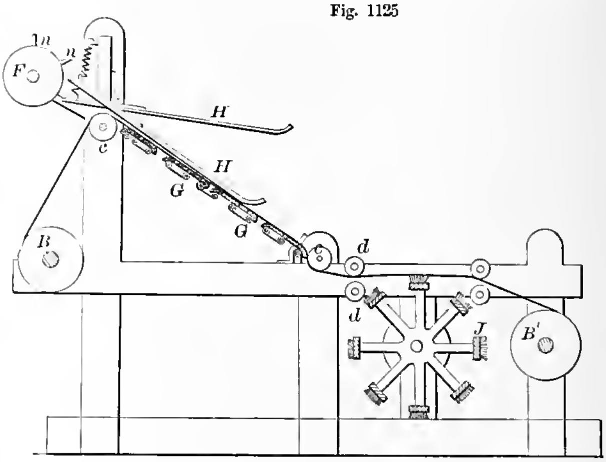


Carpet-Bag Frame.

and shut beneath the cap-piece of the frame, which is l-shaped in cross-section. The varieties and shapes are numerous.

Car'pet-beat'er. A machine in which carpets are beaten and brushed. The breadth of carpet

Fig. 1125

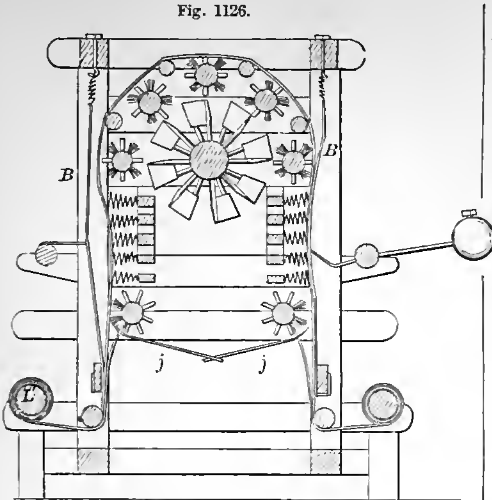


Carpet-Beater.

is wound on the roller *B*, passed over an inclined bed formed of a steam-coil *G G*, and subjected to the action of the beaters *H H*, which are tripped by the tappets *n n* on the wheel *F*. The carpet is stretched on the rollers *c c*, thence passes under *a*, is exposed to a revolving brush-cylinder *J*, and is re-wound on the roller *B'*.

Car'pet-clean'ing Ma-chine'. A brushing-machine for carpets, which is unrolled from the beam *L'*, and re-rolled on the beam at the other side of the machine, passing on its way the various cleaning-devices. These are the cords *B*, which whip it on the outside; the canes *j*, which whip it on the inside; a succession of revolving brushes, which sweep it, and a revolving fan, which blows away the dust. (Fig. 1126.)

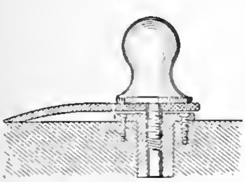
Fig. 1126.



Carpet-Cleaning Machine

Car′pet–fast′en-er. A screw-knob and screw-socket inserted in the floor with the carpet between them.

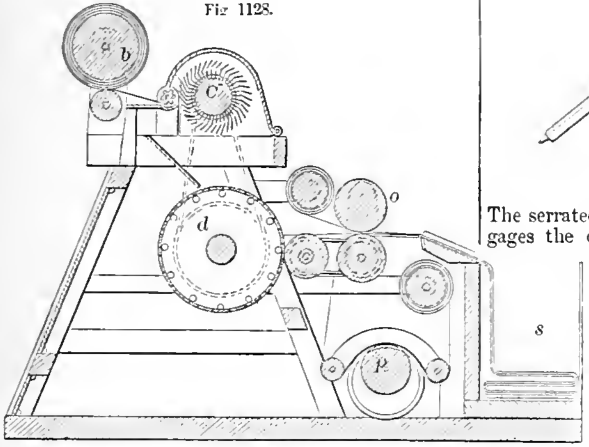
Fig. 1127.



Carpet-Fastener.

Car′pet–lin′ing. A material for placing beneath a carpet, to increase its elasticity and decrease the wear. It usually consists of a thickness of felt between two layers of paper, but there are many kinds. In the machine represented, the fibrous material from the roller *b* is formed into a fleecy mass by the carding-cylinder *C*, and collects

Fig. 1128.

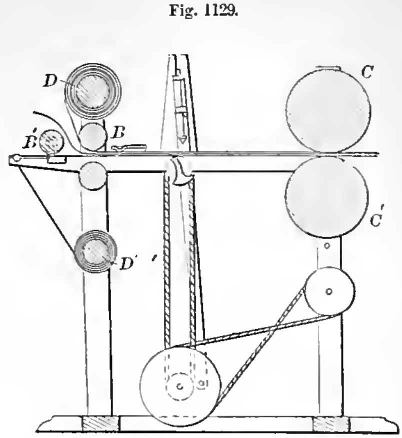


Carpet-Lining Machine.

the gauze as a bat on the gauze-covered cylinder *d*; a doffer takes it from this cylinder; it is caught between the thicknesses and pressed beneath the roller *o*. The lower sheet of paper is the wider, and is gummed on one surface by the gum-roller *R*; the edges of the wide strip are bent over the narrow one and stuck fast. The fabric is delivered into the box *s*.

In Fig. 1129 the paper is contained on two rolls *D D′*, and the webs are fed beneath the roller *B*,

Fig. 1129.



Carpet-Lining Machine

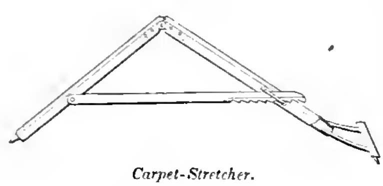
with an intervening thickness of felt shown as coming over the roller *B′*. From the smoothing-plate the fabric passes through a series of sewing-machines, by which it is quilted previously to passing between the measuring-rolls, and is pressed and delivered by rollers *C C′*.

Car′pet–loom. One for weaving carpets. See PILE-FABRIC; BRUSSELS-CARPET LOOM; JACQUARD, etc.

Car′pet–rag Loop′er. A stabbing-tool with a large eye, to carry one end of a carpet-strip through the end of the strip preceding, when one is looped over the other, to save the trouble of sewing.

Car′pet–stretch′er. A toggle-jointed frame to stretch carpets on floors preliminary to tacking down.

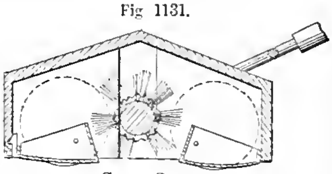
Fig. 1130.



Carpet-Stretcher.

The serrated bar at one end of the jointed staff engages the carpet, and the point at the other end extends through to the floor. A ratchet-bar is pivoted to one leg, and, passing through a staple upon the other, engages one side thereof, to keep the legs spread.

Fig. 1131.



Carpet-Sweeper.

Car′pet–sweep′er. A mechanical broom for sweeping carpets and collecting the dust and dirt in trays. The brush-shaft is rotated by a corrugated pulley driven by contact with the rubber periphery of one of the sustaining wheels.

Car-quaise′. (*Glass.*) The annealing arch of the plate-glass manufacture, heated by a fireplace called a *tisar.*

Car-reg′is-ter. (*Railway.*) A device for keeping account of all persons entering a car, so as to form a check on the receipt of fare by the conductor. It has various forms, none of which are in much favor.

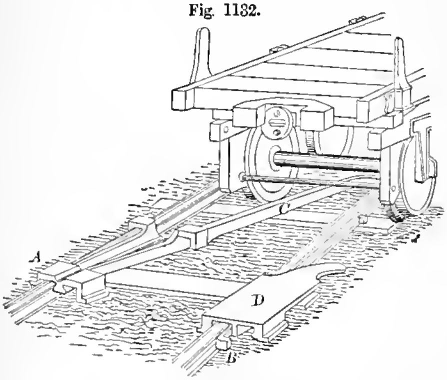
1. A turnstile at the entering side of a platform, the revolutions being transmitted by a train of gearing to an indicator.
2. A similar train actuated by the opening of the door.
3. A train actuated by the pressure of the foot on a step at the mounting and entering side of the platform.

Car-re-plac′er. (*Railway.*) An instrument or means for restoring to the rails a car which has run off the track.

This operation is frequently accomplished by the jack-screw, aided by such things as handspikes and timbers which may be convenient. A full assortment belongs to the appendages of a "wrecking" car, whose use is to remove obstructions on the track, replace cars, and lift the *débris* of an accident on to the platform-cars, which bear them to the shop for repairs or for use as material.

A number of devices have been patented for the purpose of enabling a car to ascend to its position on the rails when drawn or driven by the locomotive. The general feature in which these agree consists of

Fig. 1132.



Car-Replacer.

two inclined planes, one forming a bridge with a plate *D*, to let the outer wheel cross the rail and drop into place; the grooved plate *A* forming a bridge up to the other rail. *C* is a bar to lead the wheel towards the bridge-piece.

Car′riage. 1. A wheeled vehicle especially for the conveyance of passengers. The vehicles of the nomads of Asia were carts and wagons, two and four wheeled, in ancient times. (See CART; WAGON.) The war-vehicle of the ancients is considered under CHARIOT (which see).

The *wagons* sent by Joseph from Egypt to Canaan, to fetch his father, were no doubt *plaustra;* that is, carts drawn by yokes of oxen. Horses were not used for draft, except in chariots, and the vehicles of Egypt were two-wheeled. This form of carriage is known to have been in use as long ago as 2000 B. C., and its origin is lost in the obscurity of the remote past. The Greek tradition that wheeled vehicles were invented by Erectorius, the fourth king of Athens, about 1400 B. C., is due to the vanity of a nation who considered themselves *ne plus ultra*, in willful forgetfulness of their great instructor, Egypt, from whose fugitives they received so much. Witness Cecrops and Danaus, and the fact that Thales, Pythagoras, Aristotle, Plato, Solon, Herodotus, and others of their sages, were indebted to the land of the Nile for their eminence in science and arts. It is also quite evident that they improved upon their instructors in both.

The natives of China and India used carts from an early date, which cannot now be determined; the modern Indian cart is a good deal like its predecessor. So clumsy are they that the palanquin is likely to maintain its hold for a while yet.

The wandering Scythians from time immemorial covered their wagons with felt and with leather. (See CART; WAGON.) Athenæus, in the *Deipnosophists*, refers to "Polemo, in his treatise on the *wicker-carriage* mentioned by Xenophon."

The *hamaxa* (*'ama axōn*, of two axles) was a four-wheeled covered wagon of Persia and Greece, similar to the *carpentum* of the Romans. The body of Alexander was transported in a *hamaxa.*

The Romans had vehicles with one wheel, adapted to be drawn by slaves, and also had two and four wheeled vehicles. They also had carriages adapted for two, three, and four horses.

The use of pleasure-carriages in the city of Rome was forbidden during the republic.

Carts disposed as a circumvallation were the ordinary field and camp fortifications of many nations of antiquity, — the Scythians, Cimbri, Helvetii, Goths, Gauls, Britons, etc. The name is from the Celtic, appearing with its Latin termination as *carrus* or *carra.*

Such a fortification was known to the Romans as a *carrago.*

The Roman *arcena*, of which mention is made in the Twelve Tables, was a covered carriage used by the sick and infirm.

The *carpentum*, seen on antique coins, was a two-wheeled car with an arched covering.

The *carrucæ*, mentioned by Pliny, had four wheels, and was gorgeously trimmed. No springs.

When Rome fell, carriages and that peculiar form of luxury fell into disuse, and eventually into disrepute.

Smith's "Dictionary of Greek and Roman Antiquities" will enable the student to pursue the matter. See in that work, in addition to the above, *Pilentum, Rheda, Cisium, Covinus, Essedum, Carrus, Plaustrum, Sarracum, Petorritum.*

Down to the sixteenth century, kings, popes, ministers, and magistrates made their progresses and journeys on the backs of animals. During the fifteenth and sixteenth centuries covered carriages were used by women of rank, but it was considered disgraceful effeminacy for men to use them. In 1545 we read of a certain duke who was permitted, as a favor on account of his sickness, to ride to the baths in a covered carriage.

In 1550, three coaches were used by three of the dignitaries of the city.

During the sixteenth century carriages were introduced into Spain, Portugal, England, and other countries.

The practice gradually became more general, and in 1613 we find that ambassadors appeared in coaches at a public solemnity at Erfurth.

The carriage of Henry IV. of France had no springs or suspension-straps. The roads were neither graded nor graveled, and were almost impassable in bad weather. Horseback and pack-horses were the order of the day for passengers and freight. The magnificent Roman paved roads were forgotten.

The modern coach is claimed by the Hungarians, who say that it derived its name from *kotsce*, and that their king, Matthias Cervinus, was the first who rode in one. An edict of Philip the Fair, 1294, refers to their use, and forbids them to the wives of citizens. They were for a while restricted to the sick, to royalty, and to ambassadors.

A number of instances are cited in English history where they were used, but the roads were so execrable that the hack and pack-horse were used in England until about 1700. The making of roads preceded the extensive use of carriages, and rendered it possible. The Romans knew how important an agent in civilization were the roads, and the memorials of their genius yet remain in Europe. Facility of transportation is necessary to progress, and the early nations were either maritime or dependent upon some great river which was the artery of the empire. Witness the Mediterranean, the Nile, Euphrates, and Tigris; these waters washed all the lands of historic interest from Noah to Constantine. We must except "far Cathay," — China.

Stowe dates the making of coaches in England from 1555, and credits Walter Rippin with the making of the same. The canopies of these coaches were supported by pillars on the bodies, surrounded by curtains of cloth or leather, which were folded up when so desired. They were heavy, clumsy, and destitute of springs. They were driven by a postilion, and where four horses were used, the man who rode the near wheel-horse drove the leaders with reins. The driver's seat was added at a later period. Glass windows were added in 1631 in the carriage of Mary of Spain, the queen of the Emperor Ferdinand III. If the carriage of Henry IV. of France had been furnished with windows in 1610, Ravaillac would have been obliged to choose another mode of assassinating him. The carriage of Louis XIV. of France, 1643, was suspended from springs. The first state coach in England was that of Elizabeth. See Coach.

Stage *wagons* were introduced into England in 1564, and coaches for hire plied in London in 1625. Stage *coaches* were introduced into England by Jethro Tull, about 1750, and were employed to carry the mail in 1784. Before this time it was carried on horseback. See Coach.

See Vehicles for list of devices for land locomotion, which are treated under their respective heads.

For water locomotion, see Vessels.

Vehicles are now proposed to be made of india-rubber, all but the axles and tires.

The wood in England differs from our own. While both countries possess oak, beech, ash, and elm, the two latter differ considerably from our timber having the same names, and the English forests are destitute of many varieties which are useful to us in making the wheels, hounds, bodies, tongues, panels, etc. of carriages. Such are hickory, black and white walnut, cherry, maple, yellow poplar, locust, gum, etc.

In England, *ash* is used for the skeleton of the body of superior carriages, and beech for inferior; *elm* is used for strong planking and hubs; *oak* for spokes; *mahogany* or *cedar* for panels; *pine* and *fir* for floor and roofing; *fustic*, *lancewood*, *birch*, *sycamore*, *chestnut*, and *plane-wood* are also used.

In Australia the naves are made of blue gum, the spokes of the iron-bark tree.

2. (*Carpentry.*) The timber frame supporting the steps of a wooden stair. A *rough-string*; a *carriage-piece*.

3. The pendants from which a sword is suspended from the belt. *Sling*; *sword-sling*.

4. (*Printing.*) *a*. The frame on rollers by which the bed, carrying the form, with the *tympan* and *frisket*, is run in and out from under the platen.

b. The frame which carries the inking-rollers.

5. (*Machinery.*) A portion of a machine which moves and carries an object; as, —

a. The *log-carriage* of a sawing-machine.

The *bit-carriage* of a boring-machine, which carries the bit and is advanced to the work.

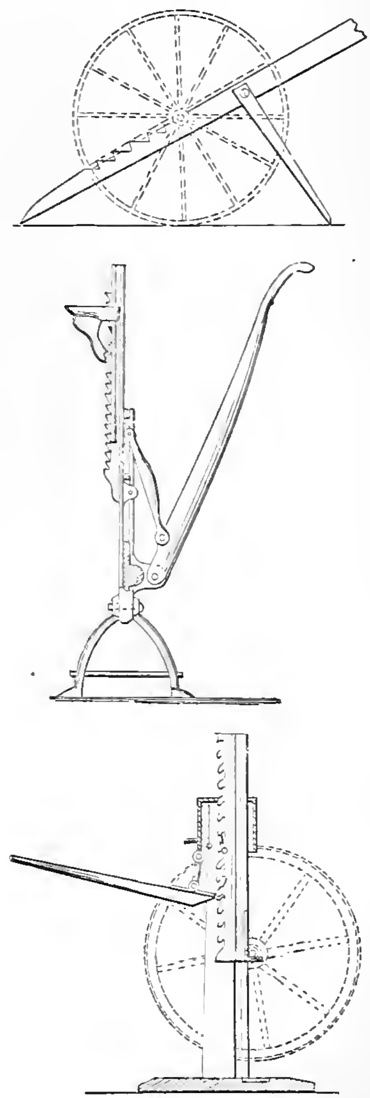
b. The *carriage* of a mule-spinner, which travels towards and from the creel on which the bobbins are skewered.

c. Of a horizontal shaft: the bearings in which it turns.

Car'riage-bolt. A screw-bolt, usually with a chamfered head, square neck, and threaded shank, for use in carriage-making. See Bolt, Fig. 767.

Car'riage-brake. A retarding arrangement for carriages when descending a hill, to prevent horses

Fig 1133.



Carriage-Jacks.

from starting too readily or moving too fast. It usually consists of a foot-lever connecting by rods to the brake-bar, which applies the shoes to the wheels.

Car′riage-bridge. A roller-bridge to be moved up a glacis and form a bridge from counterscarp to scarp, for the passage of the attacking column.

It has beams and uprights. The latter act as posts, to rest on the bottom of the ditch, and are shiftable to adapt them to the depth of the ditch or fosse.

Car′riage-coup′ling. 1. The coupling of a carriage unites the fore and hind carriages. It is called the *perch* or *reach* in carriages that possess it, but in many modern carriages is dispensed with, the bed resting on the fore and hind carriages, forming the the only coupling.

In wagons, the coupling is a pole, whose forward end is held by the king-bolt in the fore-carriage; the hind end passes through an opening between the hind axle and bolster, and the hounds of the hind axle are fastened to the pole by a pin.

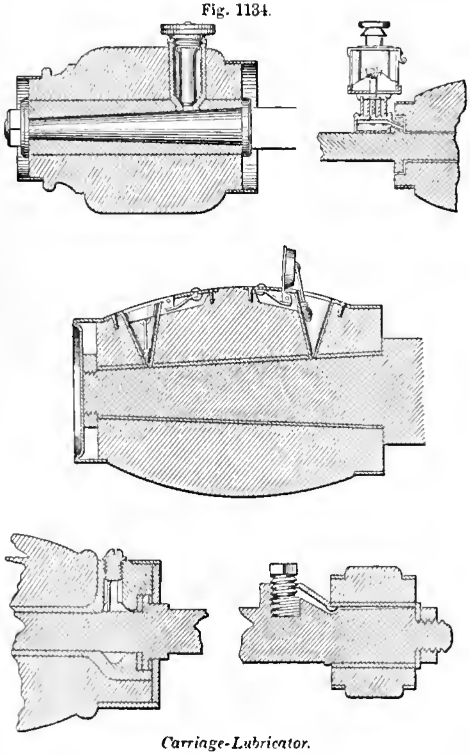
2. A means of uniting the bed to the fore-carriage. It usually consists of a king-bolt, which forms the pintle on which the fore-carriage turns, and the fifth wheel, which is bolted to keep the portions from bouncing apart.

Car′riage-guard. A plate on the bed of a carriage where the fore-wheel rubs in turning short.

Car′riage-jack. A lever-jack, made in various ways, designed to lift an axle, so as to raise a wheel above the ground, in order that it may be removed from the spindle for greasing or repair. The illustrations are self-explaining. (Fig. 1133.)

Car′riage-lock. (*Vehicle.*) A fastening for a carriage-wheel, to restrain its rotation or impede its freedom of movement in descending a hill. A *brake.*

Fig. 1134.



Carriage-Lubricator.

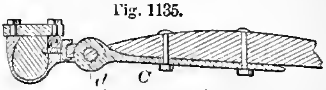
Car′riage-lu′bri-ca′tor. A means for lubricating a carriage-wheel box and spindle without removing the wheel from the axle; a self-feeding device, which will supply the wheel for a considerable time.

Fig. 1134 shows five different forms of the device. The upper one on the left has a movable screw-stopper; alongside of it is one which has a reservoir and cotton wick to supply oil; another has a spring lid to the oil-supply hole; the lower two are reached by unscrewing the stopper-lids of the reservoirs.

Car′riage-piece. (*Carpentry.*) One of the slanting pieces on which the steps of a wooden staircase are imposed. A *rough-string.* The upper end rests against the *apron-piece* or *pitching-piece,* which is secured to the joists of the landing.

Car′riage-shack′le. The bar *C*, which connects the axle-clip to the thill or shaft; *d* is the pintle.

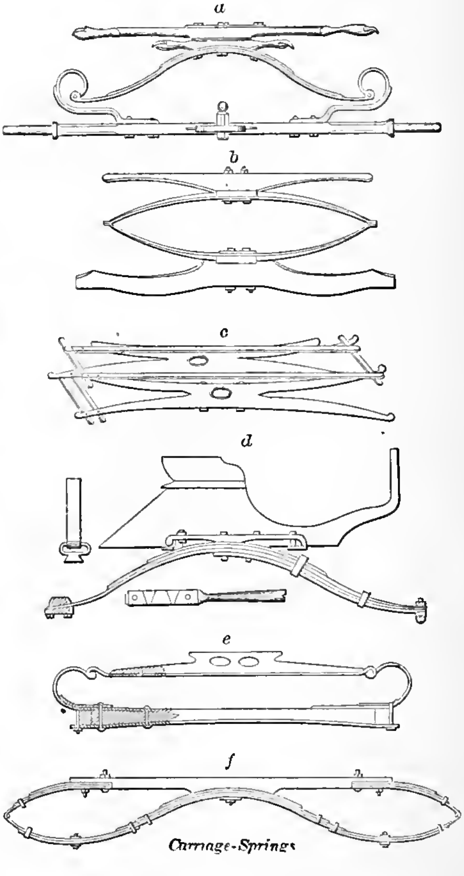
Fig. 1135.



Carriage-Shackle.

Car′riage-spring. An elastic device interposed between the bed of a carriage and its running-gears, to lessen the jar incident to inequalities in the road,

Fig. 1136.



Carriage-Springs.

and the saltatory and rolling motion of the bed itself. Several examples are shown, of which —

a has semi-elliptical springs hung upon the ends of C-springs attached to the axles.

b has the usual elliptical springs between the bolster and axle.

c has elastic wooden springs which connect the axles and also support the bed.

d has semi-elliptical springs which also couple the axles.

e has a bolster hung upon C-springs.

f has a system of curved springs with three points of connection to the bed and two to the axles.

Car'riage-step. A step, usually on a jointed dependent frame, to afford means for mounting into a carriage.

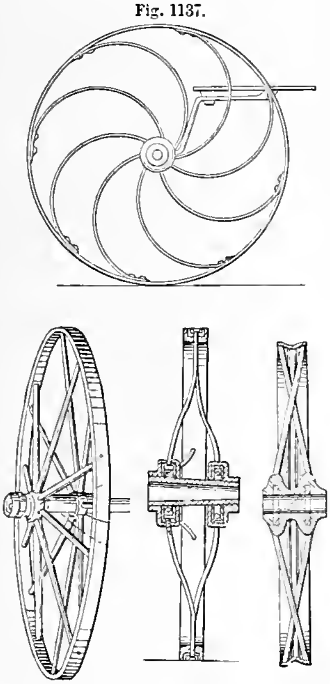
A carriage-step to be let down and raised by the opening and closing of the carriage-door was patented in England by Thomason in 1799.

Car'riage-top. 1. The cover of a carriage. Permanent in coaches; double calash in barouches and landaus; calash in some gigs, buggies, phaetons, etc.; curtained in ambulances and spring-wagons.

2. A shifting-rail on the back and ends of a buggy-seat, to make a high-back, or, by removal, a low-back buggy.

Car'riage-wheel. This has usually a hub or nave, spokes, fellies, and tire. A box fitted in the hub runs in contact with the spindle or arm of the axle, and the wheel is held on the spindle by a linch-pin, nut, or other device.

Fig. 1137.



Suspension Carriage-Wheels.

Carriage-wheels are variously constructed. In the usual form the radial spokes are planted in the hub and distend the rim. In the *suspension*-wheel, so called, the cast-iron hub and wrought-iron rim are connected by rods tightened by nuts.

The illustration gives several forms of the suspension-wheel. The upper figure has curved steel spokes, which provide in the wheels the spring or elasticity necessary for the vehicle.

The other figures show modes of securing the rims to the hubs by curved, crossed, or broad-based spokes. The run of improvement now is in the hubs and the modes of securing the spokes therein. See HUB; SPOKE; FELLY.

Car'rick-bend. (*Nautical.*) A knot formed on a bight by putting the end of a rope over its standing part, so as to form a cross; reeve the end of the other rope through the bight, up and over the cross and down through the bight again, on the opposite side from the other end. See BEND.

Car'rick-bitts. (*Shipbuilding.*) The vertical posts or cheeks which support the barrel of the windlass.

Car'rier. (*Turning.*) 1. A *driver* in a lathe, to impel the object which is supported on the *front* and *back* spindles, otherwise called the *live* and *dead* spindles. It is attached by a set-screw to the shaft to be turned, or to a mandrel on which a round object is driven for the purpose of being turned. The carrier is driven around by a projection on the *center-chuck* or *face-plate.* A *lathe-dog.*

2. A distributing-roller in a carding-machine.

3. A roller between the drum and the feeding-rollers of a *scribbling*-machine for spinning wool.

4. A spool or bobbin-holder in a braiding-machine which follows in the curved path which intersects the paths of other bobbins, and thus lays up the threads into a braid. See BRAIDING-MACHINE.

Car'ron-ade'. A short, light species of cannon intended for firing solid shot at short ranges, with comparatively small charges.

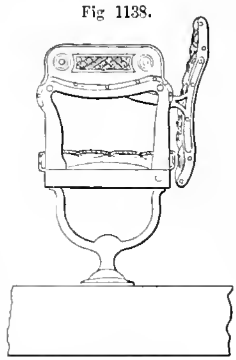
It has no trunnions, but is secured to its carriage by a bolt passing through a lug or "navel" cast on its under side. This form of gun was formerly much used on shipboard, but is now nearly obsolete.

So named from the foundry on the river Carron, Stirlingshire, Scotland, where they were first cast in 1779.

Car'ry-all. (*Vehicle.*) A light, four-wheeled family vehicle drawn by one horse.

Car-seat. A seat in a railway-car. The back is usually reversible, so as to adapt it for passengers in either direction of motion of the car, the preference being to "face the horses," as it is called. The facility for reversing is, moreover, useful in throwing two seats into a "section" for a party.

Fig 1138.

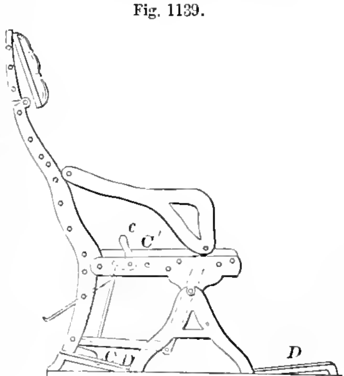


Reversible Car-Seat.

Car-seats are also made reclining, for night travel; such are termed "sleeping-chairs."

The occupant of the chair can adjust the back to any desired angle by means of a hand-lever *c*, which, on being released, allows the pawl *C* to drop into the nearest notch in the plate *D*, and hold the seat stationarily in the desired position.

Fig. 1139.



Reclining Car-Seat.

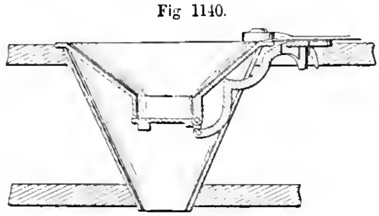
For this purpose, back, seat, and arm are pivoted together, the stationary point on which they oscillate being at the apex of the A-shaped support. As the seat slides to the rear, the back reclines, and the leg-board is projected in front.

Other car-seats are capable, by addition of parts, of being transformed into couches.

Car-seat Arm-lock. (*Railway.*) A lock attached to the bar of a seat-back, to prevent its being reversed by unauthorized persons. The bolt is withdrawn by a key.

Car-spit'toon. A spittoon inserted in the floor

Fig 1140.



Car-Spittoon.

of a car and discharging beneath. It has a valve, operated by a trigger under the control of the foot.

Car-spring. A resilient or yielding structure or material, interposed between the car and the axle to prevent the jar of the wheel being communicated to the car; or to moderate the effect of the rolling or pitching motion of the car.

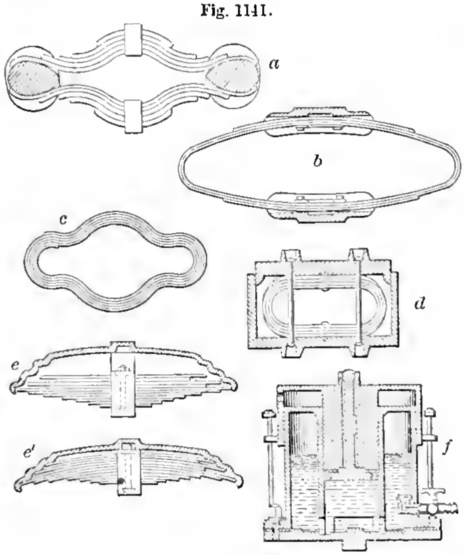
Car-springs are of various forms and materials, and are variously placed. In railway passenger-cars there are several sets, usually of different kinds, at different places between the point of jar and the car-bed. A good instance may be seen in CAR-TRUCK, where the various parts are exhibited, and the transference of the jar from one point to another is explained. See CAR-TRUCK.

Car-springs may be classed as: —

Elliptical.	Spiral.
Pneumatic.	Helical.
Torsional.	Circular plate; plane, corrugated, and segmental.
Rubber.	
Rubber and steel.	Square plate.
Rubber, steel, and air.	Bow.

In the series of illustrations the parts and structure are so evident that a short description only will be given.

Fig. 1141.



Car-Springs.

Fig. 1141, *a* is a double elliptic spring, the bearings of whose end-leaves are so shaped, that, as the spring bends beneath its load, additional leaves receive a bearing upon the ovoid bars.

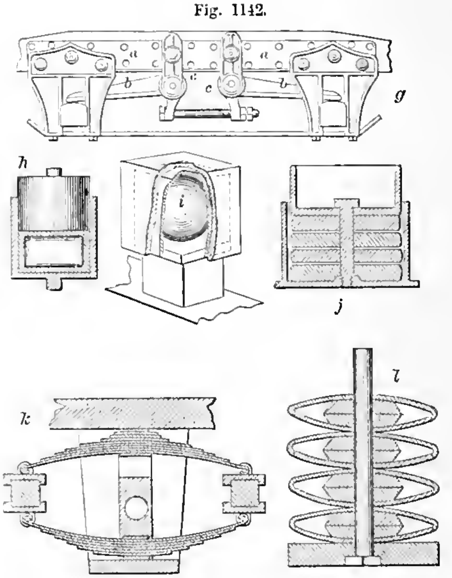
b is an elliptic spring whose principal leaves are made of a continuous plate wound round and round. Auxiliary plates above and beneath extend the area of bearing of the boxes or bars.

c is an elliptic spring made of a single plate wound around a mandrel of the shape indicated. It is designed to be used with upper and lower bars as at *b*, or in a box, as at *d*.

d shows an elliptic spring in a box, and a follower above, upon which the weight is imposed. The position of the spring, in the box, is maintained by bolts, and the upward motion of the follower is restrained by two long bolts as shown. These keep the followers from bouncing out of the box.

e shows a series of plates which assume the elliptical form *e'* when the weight bears upon them heavily. The box above the spring has a series of steps beneath, adapted to the lengths of the leaves of the spring, so that as the weight increases additional leaves obtain bearings in the box. The object is to give elasticity with light loads and strength for heavy loads, by bringing additional plates into work as the load increases. This feature of cumulative parts is found in several other forms of springs, which will be noticed in turn.

Fig. 1142.



Car-Springs.

f is one form of pneumatic spring, in which the weight is imposed upon a box whose central plunger bears upon the surface of the water in the lower box. A body of air is imprisoned in the annular portion of the lower box, and is compressed by the pressure on the water, the latter serving merely as an interposed material to transfer the pressure, as in the air-compressing machines (Figs. 71 and 72, p. 32). The central rod has a disk on its lower end, which is tightened by a screw against the lower end of the plunger, to compact the packing.

In Fig. 1142, *g* is a torsional spring, in which the weight of the truck-frame *a* is thrown upon spring-rods, which are placed transversely beneath the truck. The ends of these rods are shown at *c c*, and firmly attached to them are arms *b b*, whose ends rest on bearing-blocks above the axles. As the truck-frame sinks with its superincumbent load, a torsional pressure is brought upon the rods and by them transferred to the axle-boxes.

h is a pneumatic spring in which the air is contained in an india-rubber bag in the box, forming an air-cushion beneath the follower.

i is a hollow india-rubber ball in a box with a polished interior.

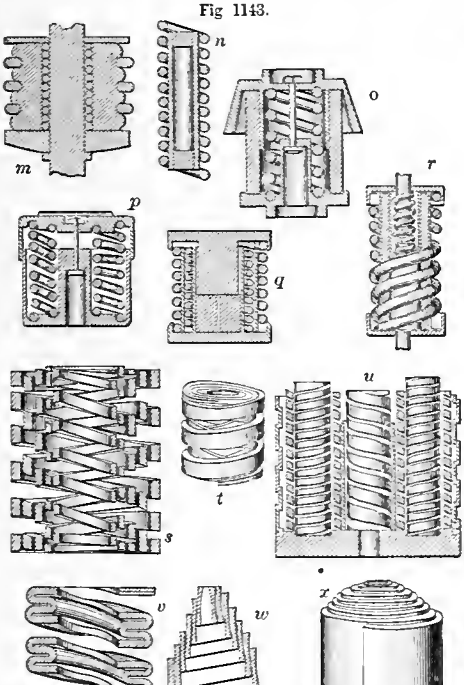
j has a number of disks of india-rubber or cork in the box, beneath the follower.

k has a combination of steel elliptic springs, with auxiliary rubber blocks at the ends.

l has concavo-convex plates fitted upon a spindle, with interposed vulcanized india-rubber disks. The plates are cruciform in plan.

In Fig. 1143, *m* is a compound spring, having a cylinder of vulcanized rubber, with an interior coil

Fig 1143.



Car-Springs.

to keep it from binding against the spindle, and an exterior spiral coil to keep it from spreading too far. The illustration shows it in its compressed condition.

n is a spring of combined steel, rubber, and air. The air is inclosed in the rubber tube, and the latter yields with the spiral envelope to the imposed weight.

o has an india-rubber cylinder inclosing a spiral steel spring, and having a bolt, to limit the extent of upward movement of the cover. The flanged rim of the cover affords a bell-mouth, into which the rubber expands.

p has the spiral steel spring contained in an annular case.

q has a pair of concentric spiral springs on the respective sides of a dividing-cylinder. In the illustration, the spring is shown as extended, in which position the follower is not in contact with the rubber cylinder, so that the latter comes in as auxiliary to the spiral screws when they have attained a certain point of depression.

r is a combination of spiral and rubber springs, with telescopic tubes which form walls.

s is a concentric arrangement of several spiral springs coiled in diverse directions alternately.

t shows a closer coil of the same general construction, but different proportions.

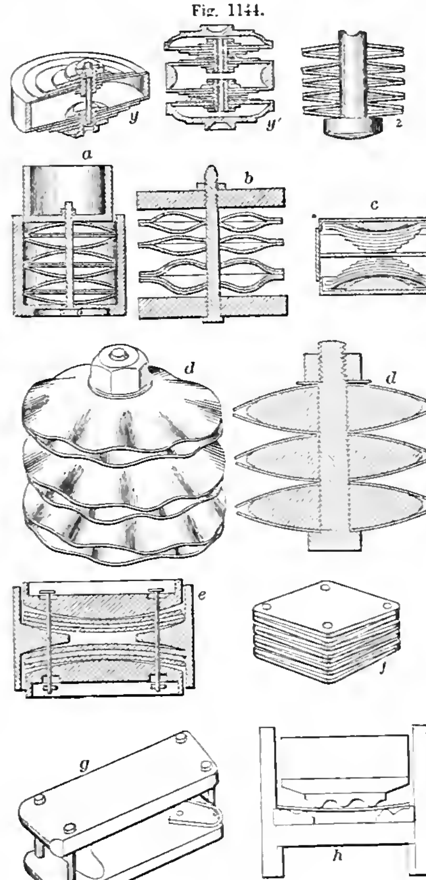
u is a congeries of spiral springs, one in the center, six in a hexagonal arrangement around the central one. Each set has a pair of spirals concentrically arranged, diversely coiled, and inclosed in its cylindrical sheath.

v consists of a steel plate folded and then bent into a spiral form around a mandrel.

w is a volute or helical spring, in which, differing from the spiral, the plate is wound on itself, and does not preserve the same diameter. The inner fold of the volute, being projected in the line of its axis, is made to sustain the load.

x is another helical spring, shown in elevation.

Fig. 1144.



Car-Springs.

In Fig. 1144, *y y'* are respectively a sectional view in isometrical projection and in simple elevation of a car-spring formed of a number of circular plates, of which those in each series are of graduated diameters. In *y* the spring is a pair of such series; in *y'* two pairs of such are allied.

z has annular dish-shaped disks arranged in pairs and united by means of a rod passing through them.

a has plates formed of segments of spheres, and alternating with flat plates in groups; the whole placed in a box in which it is subjected to the pressure of a follower.

In *b*, the spring is composed of a pile of circular plates corrugated radially and arranged round a stem.

In *c*, the spring-plates are of gradually increasing lengths upward and downward from the middle diaphragm, and are inclosed in a case whose top and bottom plates are movable and have bearings on the ends of the longer and outer spring-plates. Rubber springs are interposed between the movable plates of the case and the spring-plates.

d has several pairs of concavo-convex radially corrugated plates; between the two plates of a pair is an interposed disk of vulcanized rubber. *d'* is a sectional view of the same.

e shows a box having several metallic plates, compressed from opposite directions and shortening between bearings as they are bent. This has the effect of making them less pliable as they recede before the weight.

f has square or rectangular plates curved diagonally and fastened together at the corners, thus forming alternate pairs, which bear upon each other at the corners and diagonally through the centers; the bearing-points of the plates are changed by being lengthened and shortened when the spring vibrates.

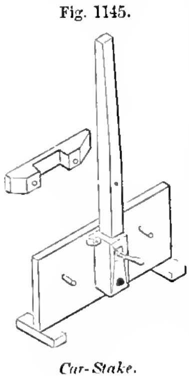
g has square, rhombic, oval, or circular plates, bent bow-shaped, and interposed between the bolsters.

h has a plate or plates so disposed between the bearing-surfaces that with a light load it rests upon its ends and has its weight at the mid-length. When the weight increases, the load is transferred to points on the upper block nearer to the ends of the spring, and the rest of the latter is transferred to points nearer the mid-length, so as to shorten the portion of spring involved in the support.

Numerous modifications and applications of the foregoing examples might be shown. The trouble is, not that matter fails for more copious illustration, but that there is not room.

Car-stake. (*Railway.*) A standard set up in iron loops or sockets on the side of a platform-car, to hold a loose load, such as lumber or the like.

Fig. 1145.



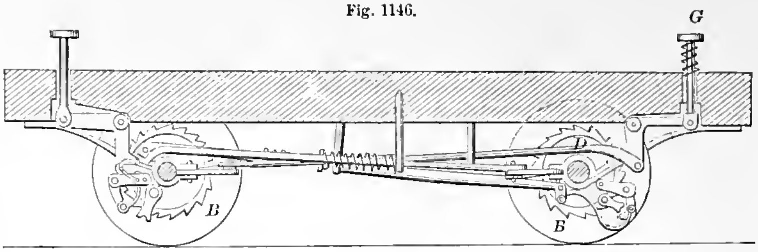
Car-Stake.

Car-start'er. (*Railway.*) A device to assist in starting a street-car from the dead-stop. These are of two kinds: —

1. Those in which the momentum of the car when the motion is arrested is made to accumulate a starting force.

In Fig. 1146 the pressure on the brake-treadle *G* causes a frictional contact between the driving-wheels *B* and the friction-wheels *D* on the same axle, which retards the motion of the drivers and condenses the spiral spring. When the pressure of the foot is withdrawn, the strength of the spring is permitted to actuate the ratchet on the wheel *B* and assist in giving the initial impulse, after which the parts assume their normal position, leaving the driving-wheels free. There are numerous modifications of the general idea.

Fig. 1146.

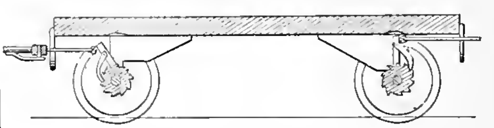


Car-Starter.

2. A device in which the power of the team is temporarily applied to give a direct impulse upon the wheel, so as to start the latter rolling, and then transfer the power to the car as usual.

In Fig. 1147 this form of car-starter is shown. The draft-pole is connected to a lever and pawl, and the latter engages a ratchet-wheel as the axle.

Fig. 1147.



Car-Starter.

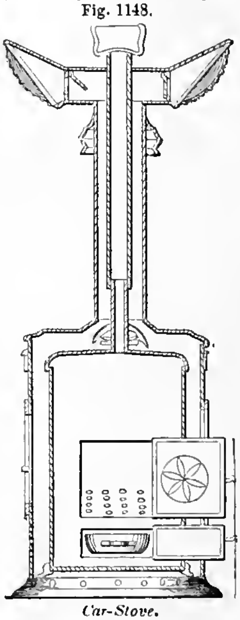
After say a sixth of a revolution of the wheel, the pawl is disengaged and the usual draft condition of the car is resumed.

Car-stove. (*Railway.*) One specifically adapted for railway cars, having certain means for securing in place, prevention of scattering of fire in case of upsetting, or arrangements for the induction of outside air, and transmission of the warmed air to the interior of the car.

Stoves are fastened by sockets in the floor, anchor-bolts, and guys.

Fig. 1148 shows a stove which has an air-induction pipe surrounding the flue-pipe of the stove. Hoods above the car-top catch the air, which passes down and occupies the air-jacket around the stove, and from whence it is discharged into the car through registers.

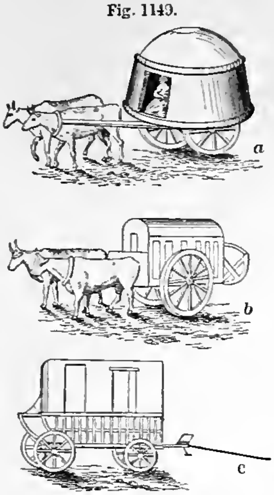
Fig. 1148.



Car-Stove.

Cart. Carts and wagons were used by the Scythians in the time of Herodotus (450 B. C.), and are mentioned a century later by Hippocra-

Fig. 1149.



Scythian Carts.

tes. The latter describes them as either four or six wheeled.

"Their wagons are the only houses they possess." — HERODOTUS, IV. 46.

These vehicles are drawn by oxen, as represented in the cut at *a b c*. The bodies of these carts are permanent or detachable; in the latter case constituting a tent-frame with a felt covering, which was readily placed on or off the running-gear of the vehicle. These are yet in use among some of the Tartar tribes, while others use carts like the gypsy habitations, unfortunately so common in England and the United States. See WAGON.

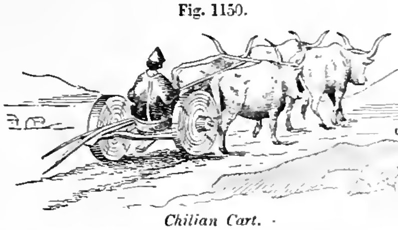
Hesiod's cart had low wheels, and was ten spans, about 7½ feet, in width.

"In default of camels, merchandise is generally transported through the deserts of Tartary by means of little two-wheeled carts. A few spars of rough timbers are all the material employed in their construction; and they are so light that a child can raise them with ease. The oxen which draw them have a small ring of iron passed through their nostrils, to which a cord is attached that links the ox to the cart which precedes him; thus all the carts are held together, and form an uninterrupted file." — *Huc's Travels in Tartary*, 1844–46.

As Strabo (19 B. C.) says: "The rest of the countries of Asia are principally inhabited by Scenites (*inhabitants of tents; Scythians*) and nomads (*hamaxœci, dwellers in wagons*), who dwell at a great distance."

Sometimes a wave breaks over the boundary, and the West sees an irruption of Huns, Turcs, or Tartars;

Fig. 1150.



Chilian Cart.

sometimes the head of the horde becomes a conqueror, as when Genghis the Khan conquered China, Persia, and Central Asia, A. D. 1206; or Timour (Tamerlane) conquered Persia, founded a dynasty in India 1402–1749, and broke the power of the Turcs in Asia Minor.

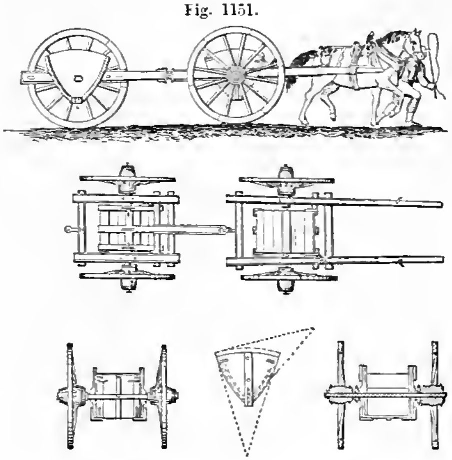
The Chilian cart *d* is a good illustration of the primitive vehicle on wheels. Its wheel consists of disks sawn or chopped from a log and bored for the axle. The tongue or pole is secured to the axle and forms the frame of the bed, somewhat like a city dray.

Enlargements on the centers of the wheels outside form hubs, to prevent the wobbling of the wheels on the spindles. The hub and spindles, being of wood, and having a plentiful lack of grease, make music, — such as it is.

The French Engineer Perronet, who executed so many heavy public improvements during the last century (b. 1708; d. 1794), seems to have been capable of great projects, original devices, fanciful ornamentation, graceful designs, and effective details.

His ingenuity was manifested in the centering of his arches, coffer-dams, hydraulic and hoisting ma-

Fig. 1151.



Perronet's Carts.

chines, and in many other departments which we have had occasion to refer to in their proper places.

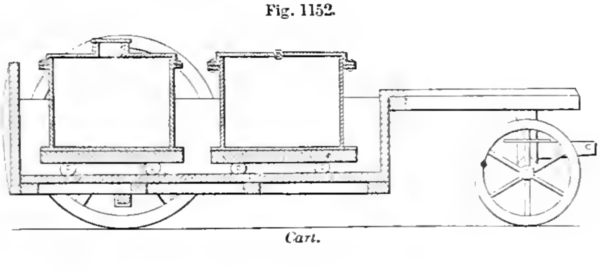
For removing the earth excavated in constructing the foundations of his numerous bridges, he used carts in pairs, coupled together.

Each cart had a bed capable of holding half a cubic yard of earth, and so suspended from the axle that a part of the contents was below the same, nearly balancing the load, so that the earth was easily dumped. In the rear of the forward cart-frame was a shackle, by which another cart was attached. Each cart could, therefore, be separately loaded and drawn into the regular track along which it was conveyed.

The shafts and frame were of timber, and the axle of iron. The wheels were large, and were placed far apart, to avoid upsetting. The rear carts had poles, the forward ones shafts.

The modern cart in England is adapted for many uses. With wide-spreading *raves* it is much used on the farms, especially in some parts of the country. The carts of the various trades, as coal-merchants, butchers, market-men, and others, cannot be more than referred to here. The cart Fig. 1152 is a low

Fig. 1152.



Cart.

body adapted for freight or express boxes, night-soil, or city drayage. The hind axle is bent, and the fore-end of the cart rests on a fore-carriage, constituting it a wagon, or very nearly so.

Dumping-carts for removing earth have a bed hinged to the axle, and adapted to tilt up and discharge the load when so desired.

Manure-carts are made in Britain specially adapted for distributing liquid or partially liquid manure either broadcast or in drills. They are fitted with pumps so as to be loaded from the tanks, and the distribution is made by perforated pipes or traveling-buckets.

Manure dumping-carts are also used, the barrel-shaped reservoir turning on its axis to discharge its contents.

A manure-cart is also sold in England, having a rotating spiked roller which distributes the barn-yard manure from a cart or wagon as the vehicle passes over the ground.

Car'thoun. (*Ordnance.*) The old cannon-royal, carrying a 66-pound ball. It was 12 feet long, and had a caliber of 8½ inches.

Cart-lad'der. (*Vehicle.*) A rack thrown out at the head or tail of a cart, to increase its carrying capacity. Called *raves* in some places.

Car'ton. Pasteboard for paper-boxes.

Car'ton-pi-erre'. 1. A species of papier-maché, imitating stone or bronze sculpture. It is composed of paper-pulp mixed with whiting and glue. This is pressed into plaster piece-molds, backed with paper, and when sufficiently set, removed to a drying-room to harden. It is used for picture-frames, statuettes, and architectural ornaments.

2. Very hard pasteboard.

Car-toon'. A sketch in chalk made on rough paper, to be transferred by pricking through on to a freshly plastered wall to be painted in fresco. Among the most celebrated are those of Raffaelle.

Car-touch'. 1. (*Architecture.*) A modillion or console supporting the eave of a house.

2. (*Fire-arms.*) *a.* A cartridge; a roll of paper containing a charge.

b. A case filled with shot to be fired from a cannon. (Obsolete.)

Car-touch'-box. A portable case in which cartridges are carried. A cartridge-box. See ACCOUTERMENTS.

Car'tridge. A "round" of ammunition, including the ball with the sabot, if any, and its projecting charge, enveloped in a single case.

This is a modern institution, it having been originally customary to employ loose powder and ball.

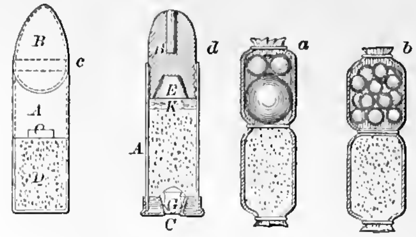
Then followed a cartridge containing a measured quantity of powder, the bullets being carried separately in a bag. The end of the paper cylinder was bitten off and the paper used as a wad. Gustavus Adolphus (killed at Lutzen, 1632) is said to have been the first to have made up the cartridge with a measured quantity of powder and a ball fastened thereto.

Sir James Turner, in the time of Charles II. of England, speaks of cartridges employed by horsemen, carried in a "patron" which answered to the modern cartridge-box. After this time it appears that cartridges were carried in cases suspended from *bandoliers*, equivalent to the more modern bayonet scabbard-belt.

Soon afterward the great improvement — the cartridge-box — was adopted, which still, under various modifications, continues in use. See ACCOUTERMENTS.

Plain, round ball, and buck and ball cartridges

Fig. 1153.

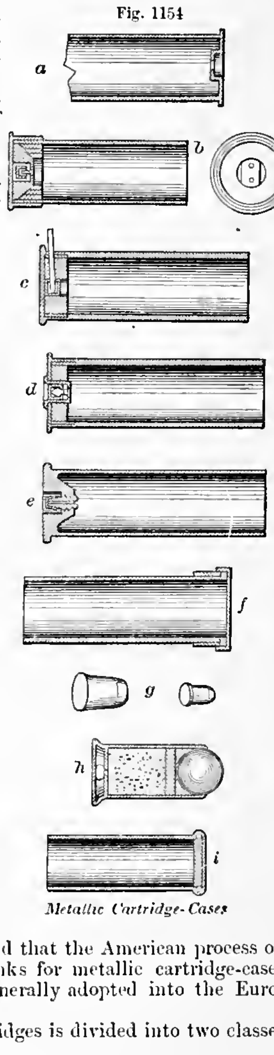


Cartridges.

are now practically obsolete. These were formed of a paper cylinder, which was partially filled with powder and choked near its mid-length by twine, the powder occupying one end and the ball the other. Other substances than paper, as animal intestines prepared in a peculiar way, were sometimes employed. Colt covered his cartridges with tin-foil, and afterwards a paper saturated with nitrate of potassa was introduced. This might be placed in the gun as it was, the covering facilitating, rather than retarding, the ignition of the powder. In Fig. 1153, *a* is a *buck and ball* cartridge, *b* one having buckshot only, *c* the Prussian needle-gun cartridge (see FIRE-ARM). In this the bullet *B* has a sabot *A*, separating it from the powder *D*, and having at its base a cavity *C*, for the reception of fulminate. The case of this cartridge is made of paper.

d, Snider's, for the muzzle-loading Enfield rifle converted into breech-loading (see FIRE-ARM), is made up of a sheet-brass cylinder *A*, into which is inserted the bullet *B*, having at its base a recess *E*, which contains a plug of clay. Back of this is the powder-chamber, having at its base a sabot *G*, into a cavity of which fulminate is inserted and exploded through the action of the firing-plunger on a cap *C*.

Fig. 1154



Metallic Cartridge-Cases

It may be remarked that the American process of drawing out the blanks for metallic cartridge-cases into tubes is now generally adopted into the European services.

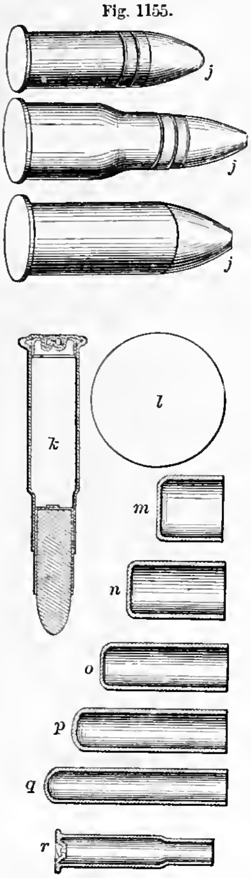
This style of cartridges is divided into two classes

— *rim* fire and *center* fire, — the first having the fulminate arranged within a cavity around the interior of the flange, and the latter having it arranged at the center of the head or base of the cartridge. Each kind requires the hammer or firing-pin of the gun to be specially arranged, in order to strike the cartridge at the proper point, though cartridges have been devised in the United States to be both *rim* and *center* fire, and guns have also been made to fire either or both kinds of cartridges.

The idea of using sheet metal for this purpose seems to have originated with the French.

In 1826, Cazalat patented a cartridge of this kind (*a*, Fig. 1154), having a receptacle with a covering patch of water-proof paper for fulminate at its base. A hole in the bottom of the cup admitted fire to the charge. This appears to have been in advance of the age, being drawn from a single piece of copper, and being *center-fire*. *b* and *c* represent two forms of the Lefaucheux cartridge, — one of the earliest of this kind. In *b*, the cap is secured to an anvil-block; in *c*, a plunger, struck by the hammer, explodes a fulminate placed in a chamber at the base.

Fig. 1155.



Metallic Cartridges.

d, *e*, show modifications of this, the anvil and cap principle, in which the pin is dispensed with.

f. One of the earliest-known cartridges is that of Roberts, of Paris, 1834, in which an annulus was formed at the base to contain fulminate.

g is the Flobert cartridge, in which is a ball with a charge of fulminate at the base, which does the duty at once of priming and propelling, adapted for target-practice at short ranges.

h, *i*, Smith and Wesson patents, 1854, 1860. In the first of these the fulminate was contained in a capsule at the base, and in the latter in an annulus within the flange surrounding the base of the cartridge, and secured in place by a pasteboard disk.

j, *j*, *j*, show some other forms of metallic cartridge as now commonly used.

k is the Berdan cartridge; this has an exterior central recess, a bottom to receive the cap, which is exploded upon an anvil turned up on an interior metallic lining. The case is adapted to fit a chamber larger in diameter than the bore of the barrel.

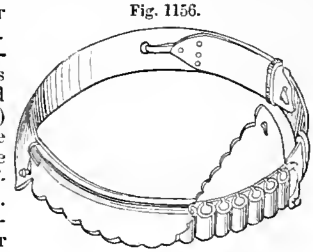
The mode now generally adopted for forming metallic cartridges is to punch the blank out from a sheet of brass, and to draw it between successive rolls and punches until it assumes the required shape. The shape which the cartridge-case assumes during the different stages of the process is shown in the figures *l* to *r*.

Cannon-cartridges for 6 and 12 pounder smooth-bored field-guns, the former of which may now be considered obsolete, have the powder-charge, contained in a woolen or silken bag, and the projectile united together by twine. For larger smooth-bored and all rifled guns, the powder is put up in a separate bag, still, however, retaining the name of cartridge.

Car′tridge-bag. (*Ordnance.*) A flannel bag holding a charge of powder for a cannon.

Car′tridge-belt. A belt for the waist or to go over the shoulder, having pockets for fixed ammunition.

Fig. 1156.

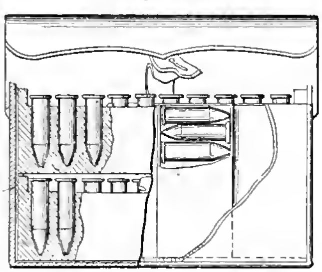


Cartridge-Belt.

Car′tridge-box. Gustavus Adolphus (killed at Lutzen, 1632) reduced the weight of the musket from fifteen pounds to ten. He also introduced the paper cartridge, which at first only contained the powder, the bullets being kept in a bag.

Cartridge-boxes at first were very small, but the Germans soon enlarged them so as to contain forty rounds. Nevertheless, for a long time after, priming was done with a powder-horn, until at length the plan of using some of the powder of the cartridge was hit upon.

Fig. 1157.

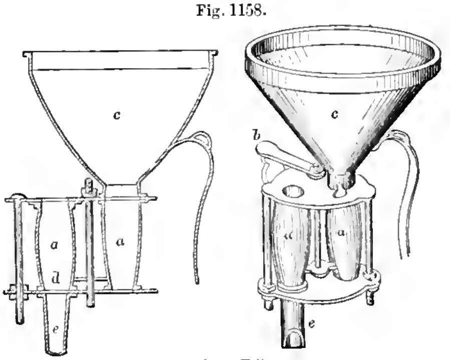


Cartridge-Box.

Cartridge-boxes are made to contain such number of rounds as may suit the service. Some are specially adapted to certain kinds of ammunition, as the Spencer, for instance. (See ACCOUTERMENTS.) Some are designed to give each cartridge a pocket, to prevent their jumbling about. One of them is circular, having radial pockets; another has flaps and loops, like a homœopathic dispensary.

Car′tridge Fill′er. A device for charging cartridge-

Fig. 1158.



Cartridge-Filler.

cases with the proper quantity of powder. In that shown, the two filling-tubes *a a* are partially rotated by the lever *b*, so as to bring each of them alternately under the funnel *c*, and over the discharge-aperture *d*; while one is being filled, the other is discharging its contents into a cartridge-case through the pipe *e*.

Car'tridge-pa'per. A strong paper of which cartridges are made. It is of various sizes and thicknesses, according to the kind of cartridge to be made, ranging from a quality similar to bank-note paper, employed for small-arm cartridges, to that used for cannon cartridges, which is about the thickness of thin pasteboard, but rougher and more flexible. The latter is, however, now seldom or never used. The different qualities are in the United States service numbered from 1 to 6, the latter being the coarsest and thickest.

Car'tridge-prim'ing Ma-chine'. A machine by which the fulminate is placed in the copper-capsule of the metallic cartridge. The fulminate is differently disposed for center-fire and for rim-fire cartridges; in the latter the cartridge-case is rotated on its longitudinal axis, to dispose by the centrifugal action the fulminate at and about the flange.

Car'tridge-re-tract'or. That part of a breech-loading fire-arm which catches the empty cartridge-capsule by its flange, and draws it rearwardly from the bore of the gun.

Car'tridge-wire. 1. (*Blasting.*) The priming-wire whereby the cartridge is connected to the conducting-wire of the voltaic battery.

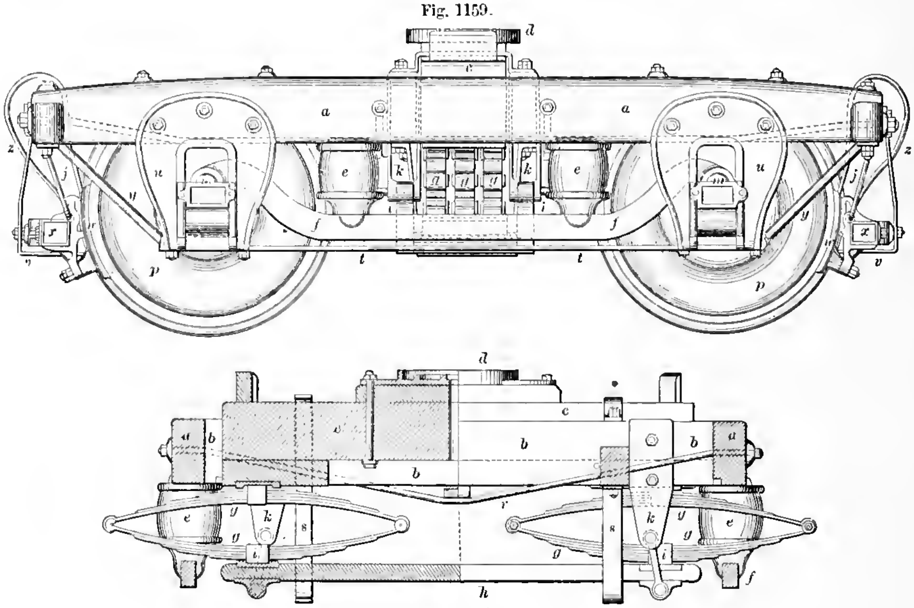
2. (*Ordnance.*) The needle whereby the cartridge-envelope is pierced, in order that the priming may connect with the powder of the cartridge.

Car-truck. (*Railway.*) A wheeled carriage beneath a railway car. The first railway cars had wheels on axles, arranged similarly to those of a wagon. It was afterwards found more convenient and efficient to shrink the wheels on to the axle, so that they might revolve together; but even then the pedestals of the axle-boxes were attached to the bed of the car, as is yet the case generally in Europe.

The American practice has long been to support the car on two four-wheeled trucks, and latterly six-wheeled trucks have been used under a superior class of passenger-cars. The capacity, duty, and endurance of car-wheels is alluded to under CAR-WHEEL; but it may be here stated that the addition of the two wheels to the truck increases by one half the number of parts involved in the duty of supporting the load.

There are many kinds of trucks, but they agree in the feature of swiveling beneath the car-bed as the car rounds a curve, and in having a certain freedom of motion which is not as necessarily transmitted to the car as it would be, on a truck of a giv-

Fig. 1159.



Car-Truck.

en quality, were the axle-boxes on pedestals attached to the car-bed directly.

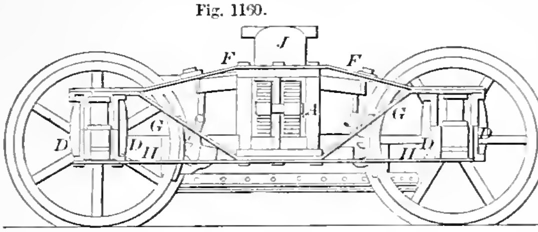
In the illustration, *a a* are the longitudinal timbers of the frame of a passenger-car truck, such as may be found on some of the best of our railways. *b* is one of the transverse timbers of the frame. Within this frame is suspended the *swinging-bolster c*, having at its mid-length the *center-casting d*, which forms the bushing for the king-bolt, and also what may be called the "fifth wheel," on which the car-end oscillates as it swerves, rolls, and pitches. The car-frame *a b*, while supporting the car-end through the medium of the swinging-bolster as described, is itself supported through the medium of the *gum-springs e e*, a pair on each side of the truck upon the equalizing bar *f*, whose ends rest upon the upper boxes of the axle-bearing. This is the account in short, but there are several other parts involved, as will appear by tracing the sequence of the impositions from the car to the rail.

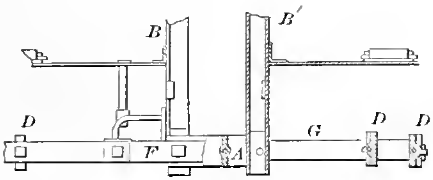
The car-end rests upon the *center-casting d*, which is in a position mid-length of the *swinging-bolster c*; this rests upon the upper members of the *elliptic springs g g*, which are founded upon the *suspension-bar h*, which connects the two points of imposition of the springs *g g*, making each a brace for the other. The suspension-bar *h* is suspended by *yokes i i*, from *hangers k k*, which are bolted to the *transverse-tim-*

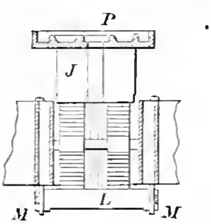
bers b b of the truck-*frame*, of which they form a part. The *longitudinal timbers a a* of the frame, on each side of the truck, rest upon the *gum-springs e e*, and these upon the *equalizing-bar f*, whose ends are upon the upper boxes *m m* of the axle, outside of the wheel *p*. For the detail of this portion see AXLE-BOX.

The upper illustration of Fig. 1159 is a side elevation, and the lower one is a section, the respective halves of the view being taken on different section-lines. *r* is a tension-bar or *tie* to strengthen the frame; *s s* are *safety-stirrups*, to catch the *suspension-bar h*, if anything should give way; *t* is a *brace-rod* between the two *pedestals u u*, in which the axle-box works up and down as the gum-springs contract or expand. *w w* are the *brake-shoes*, on the end of the *brake-bars x x*, which are moved by a rod and lever arrangement. (See CAR-BRAKE.) *y y* are *diagonal-brace rods* for the *pedestals*. *z z* are the *relieving-springs* which throw the shoes away from the wheel when the tension on the brake-mechanism is withdrawn. *v v* are the *safety-stirrups*, to catch the brake-bars if the *swing-bars j j* should give way.

Fig. 1160.







Car-Truck.

Thus it will be seen that two sets of springs intervene between the car and the rail; the car-end rests upon a swinging-bolster which has elliptical springs beneath it, and these are suspended from a frame which itself rests upon gum-springs on the equalizing-bar which rests on the axle-boxes.

There are many modifications of the general form shown in Fig. 1159, but the feature of a spring-supported bolster "swinging" within a frame-spring supported on the wheel-axles is generally maintained.

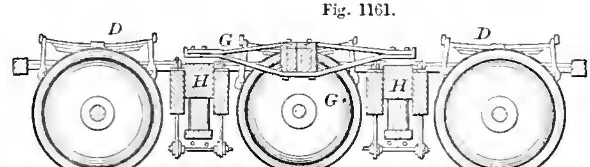
In Fig. 1160 is shown one modification, in which the sides of the frame are iron trusses, each composed of a plate *F F*, tie *H H*, and braces *G G*, having guides *D D*, which act as pedestals in which the axle-boxes ascend and descend, as the springs give way and recover themselves. Within the side trusses are bolted the ends of the transverse frames *A B B′*. *P* is the center-casting, which rests on a post *J*, and this upon the elliptic springs in the frame *A B*, as shown in the upper portion of Fig. 1160, and on an enlarged scale in the lower left-hand corner of the same figure. The springs rest on the bar *L*, and the weight is transferred by hangers *M M* to the main frame and trusses, which, as has been said, rest on the axle-boxes. The mechanism for operating the brake-shoes need not be particularly described.

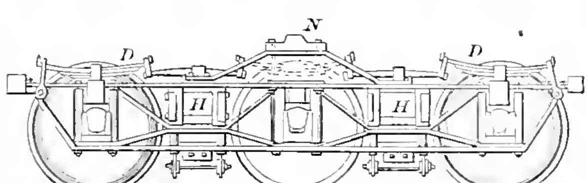
Fig. 1161 represents a vertical longitudinal section and side elevation of a six-wheeled truck. This has a rigid frame, maintaining the wheels in the same line at all times, but allowing them to run over curves in the track by having the flange removed from the middle wheel of each trio. The truck is so supported that the weight is equally distributed upon all the wheels, by resting it upon a support over, but not upon, the middle axle, said support being sustained by springs placed on each side of and equidistant from the middle axle, and the whole weight being transferred to the axles through a rigid frame.

The weight of the car-end, in this case as in the previous examples, is taken upon the central beam, and is then transferred to swinging-bolsters *H H*, which rest on gum-springs, and these upon transverse bars, which are suspended by stirrups from the main frame, which, in the example before us, is an iron truss-frame. The truss-frame is suspended from elliptic springs, which rest eventually upon the axle-boxes. *N* is a side-bearing block, to restrain undue lateral oscillation of the car.

Fig. 1162 shows a portion of an eight-wheeled truck which is composed of two independent four-wheeled trucks connected together by means of a platform *A*, which is supported upon and connected by pivots to laterally swinging bolsters *D* on each sub-truck (one only shown). The end of the coach is supported on the middle transverse swinging-bolster *K* of the frame *A*, and the swinging-bolsters in the middle of the sub-trucks abut upon rubber blocks at their ends, and rest upon rubber blocks whose supports are swung from the sub-truck frames *b b′ c*, and by them transferred to the elliptic side-springs *f*, which rest upon saddles over the axle-boxes. *J J* are truss-rods which strengthen the main frame.

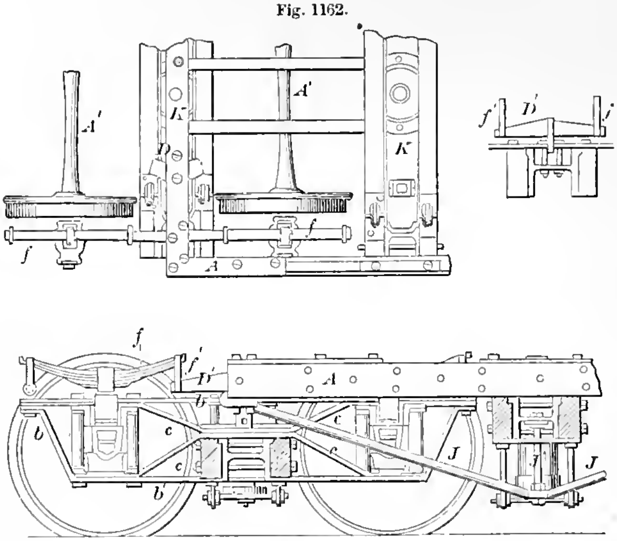
Fig. 1161.





Car-Truck.

Fig. 1162.



Car-Truck.

With lighter cars, such as those of street railways, this combination of great strength and elasticity is not required.

In Fig. 1163 is shown a car whose bed is supported, on each side, at four points, by means of four pedestals, as many rods, and two semi-elliptic springs.

Car-truck Frame. The strong wooden frame which rests upon the wheels by intermediate springs and parts, and which by other intermediate springs supports the swinging-bolster upon which the car directly rests. See CAR-TRUCK.

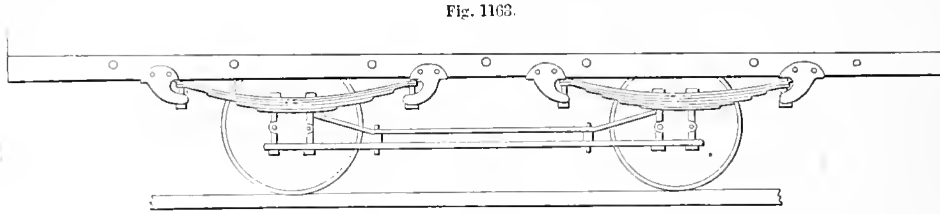
Car-truss. That combination of sills, plates, braces, and tie-rods which forms the skeleton of the car, and upon which, as a frame, the floor, sides, roof, etc., are fastened.

Cart-sad'dle. The saddle upon which rests the chain which goes over the horse's back, and whereby the shafts of a cart are supported.

Car'vel-built. (*Shipbuilding.*) *a.* A mode of building in which the timbers are cut out of the solid, as in ships and the larger description of boats, such as launches, long-boats, and barges. (See BOAT.) The planks make flush seams instead of lapping, as in the *clincher-built.* The seams are calked. The frame of a carvel-built boat generally consists of a floor and two futtocks.

b. A mode of joining the plates of iron vessels, in which the edges of the plates are brought flush together and riveted to a lap or *welt* in the rear. In *clincher-built* iron vessels the plates overlap, and are secured together by one longitudinal row of rivets.

Fig. 1163.

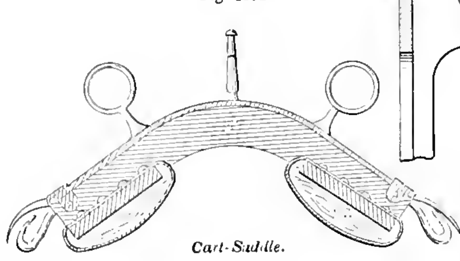


Car-Truck.

Car'vel-joint. A *flush* joint; said of ship's timbers or plates, in contradistinction to *clincher.* See CARVEL-BUILT.

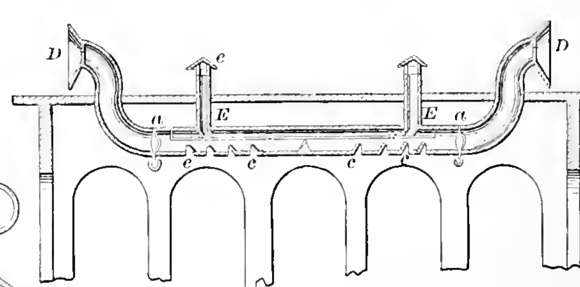
Car-ven'ti-la'tor. (*Railway.*) A device for bringing fresh air into a car and removing noxious air therefrom. Fig. 1165 is one form, in which a cowl or hood *D* on the roof catches the air, which is filtered through a gauze screen and led down through the roof of the car. Crescent-shaped openings *c* deflect the air into the car, and other openings lead up the foul air, which is discharged through the vertical pipes *E*. The mouths of the dampers *D D* are presented fore and aft respectively, and one of the dampers *a* is moved, to close the pipe, according to the direction in which the car is moving.

Fig. 1164.



Cart-Saddle.

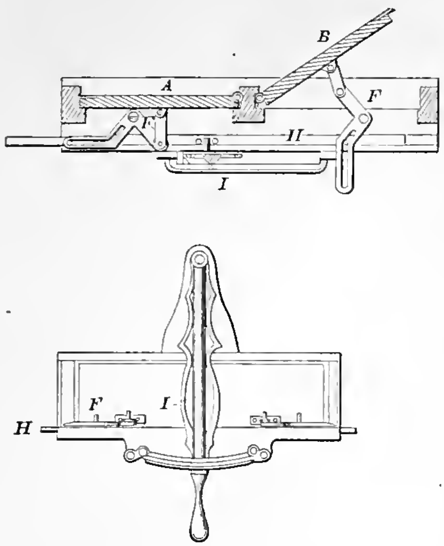
Fig. 1165.



Car-Ventilator.

The device shown in Fig. 1166 is designed to open or close simultaneously all the alternating shutters on one side of the turret of "monitor cars." All the shutters may be closed at once, yet it is the

Fig. 1166.



Car-Ventilator.

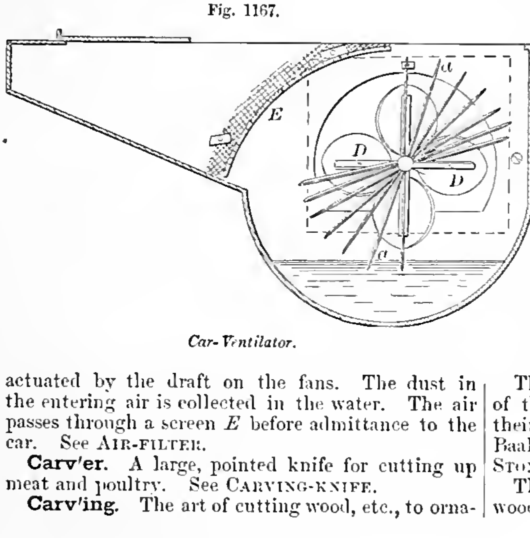
practice to have one half of the shutters open while the carriage is moving in one direction, and to reverse the position of the shutters — i. e. open those which are closed and close the open ones — when the carriage moves in the opposite direction.

The mechanism for operating the shutters consists of the slide-bar *H* and its operative lever *I*, and a series of slotted and bent levers *F*, and their connecting links. The slide-bar *H* runs the length of the car-turret. In the upper figure, which is a horizontal section, the rear shutter *B* is shown open, and *A* closed. In the lower figure, which is in elevation, the lever is clearly shown by which the series of ventilating-shutters are operated.

In Fig. 1167 is shown an adjunct, consisting of a means of removing the dust from the air entering the induction-openings *D*.

The paddles *a* on the rotating shaft dip into a water-bath at the bottom of the ventilator when

Fig. 1167.



Car-Ventilator.

actuated by the draft on the fans. The dust in the entering air is collected in the water. The air passes through a screen *E* before admittance to the car. See Air-filter.

Carv'er. A large, pointed knife for cutting up meat and poultry. See Carving-knife.

Carv'ing. The art of cutting wood, etc., to ornamental forms by means of chisels, gravers, scorpers, etc. With metals, it becomes *chasing;* with plastic material, *molding.*

It is a very ancient art, having been employed in Assyria, Babylon, Persepolis, Egypt, and Greece upon chariots, furniture, weapons, and many other objects.

It was about 1491 B. C. that Bezaleel, of the tribe of Judah, was specially selected for his skill as a workman in gold, silver, brass, gem cutting and setting, and *carving in wood,* and was commissioned to execute the work upon the Tabernacle and its furniture. Aholiab, of the tribe of Dan, was his first assistant, and he had other coadjutors not mentioned by name. The Egyptians, among whom Moses, Bezaleel, and others, had been educated, were justly renowned for their skill and taste in carving, as is abundantly shown by their chairs, biers, couches, arms, chariots, musical instruments, and other articles cited under their respective heads in this work. To mention one specially, their chairs left little to be desired or attempted either in comfort, beauty, or upholstering. See Chair.

The ornamentation of the Temple of Solomon, and its furniture, about 1005 B. C., called for the skill of a workman who was of a mixed Tyrian and Israelitish descent. His skill in carving and casting was derived from his father, who followed the business of a pattern-maker and bronze-founder in Tyre.

The ornamentation of the day consisted of copies of natural objects, formally associated, resembling that which, frozen into conventional forms, gave a severe grace to the Grecian architecture. The capitals of the bronze columns erected by Hiram Abiff were ornamented by "nets of checker work, and wreaths of chain works," lilies and pomegranates being strung upon the pillars and their capitals.

"Hiram made the lavers, and the shovels, and the basins. The two pillars, and the bowls of the chapiters on the top of the two pillars, and the two networks to cover the two bowls of the two chapiters, — and four hundred pomegranates for the two networks, even two rows of pomegranates for one network, — and the ten bases, and ten lavers on the bases; and one sea, and twelve oxen under the sea; — all these vessels were of bright brass" (bronze), and were cast in the plain of Jordan, "in the clay ground between Succoth and Zeredathah."

These utensils, together with the great sea of bronze which held 2,000 baths, required great skill in carving and casting, and are deemed very remarkable for the time at which they were executed. The surprise expressed arises from our own vanity and depreciation of the skill of those who preceded us a few thousands of years. The bath, as estimated by Josephus, was equal to $8\frac{5}{8}$ gallons (8.6696); according to the Rabbinical writers, $4\frac{1}{2}$ gallons nearly (4.4286); Smith estimates it at $7\frac{1}{2}$ gallons. Taking the lowest estimate, the brazen (bronze) sea of the temple court held over 9,000 gallons. The Chaldees broke it in pieces to remove it to Babylon, about 590 B. C. They estimated it only as so much metal; they "carried the brass [bronze] of them to Babylon." This was a large vessel, and may well be believed of the time when works of art were estimated by their colossal proportions. The stones of Egypt and Baalbec are yet unrivalled in modern times. See Stone-cutting.

The doors of Solomon's Temple were of olive-tree wood, and on them were carved "cherubim and palm-trees and open flowers." The carving was overlaid with gold. Other doors were of fir, similarly carved and plated.

The doors of the temple of the Indian idol Somnauth were of sandal-wood elaborately carved. They were taken by Mahmoud of Ghizni, A. D. 1024, and were made the entrance-doors to his tomb in Afghanistan. They were retaken by the British in 1842, and the Governor-General, after a pæan in their praise worthy of a *fakir*, ordered them to be restored "with all honor" to the obscene idol, "avenging the insult of 800 years." Good sense stepped in and countermanded the absurd order. See DOOR.

Carv′ing-chis′el. A chisel having an oblique edge and a basil on both sides. A *skew* chisel.

Carv′ing-knife. A large-sized knife used for cutting meat at table. It is usually handsomely mounted. The carving-knives of two centuries since were a part of the state service of the refectory.

Fig. 1168.

Grace-Knives.

Those represented had the grace before meat and that after meat, with the music of the intonation.

Achilles carved for his visitors, and each was expected to eat his mess without grumbling. Joseph sent to Benjamin a larger mess than to either of the other brothers.

As to behavior at table, we learn from Plutarch and others that paring the nails at table was the height of vulgarity; speaking loud, spitting and coughing, were unregarded trifles. As the guests had no forks, they wiped their greasy fingers on soft bread, which they then threw to the dogs. "The dogs eat of the crumbs." Napkins came into fashion later.

In after ages each man grasped the joint and carved for himself. (See CASE-KNIFE.) Table-forks are a much later thought; they came from Italy to England in the time of the Stuarts. See FORK.

Bread, meat, and beer formed the usual feed of our ancestors in England down to and during the reign of Elizabeth, and the people busied themselves curiously in the modes of carving, inventing a whole category of technicals. Juliana Berners, lady prioress of the nunnery of Sopewell in the fifteenth century, the reputed author of the "Book of St. Albans," gives the following as the terms applied to carving the respective animals: —

"A dere was broken, a gose reryd, chekyn frusshed, a cony unlaced, a crane dysplayed, a curlewe unioynted, a quayle wyngged, a swanne lyfte, a lambe sholdered, a heron dysmembryd, a peacock dysfygured, a samon chynyd, a hadoke syndyd, a sole loynyd, and a breme splayed."

Carv′ing-ma-chine′. One for carving wood, or roughing it out preparatory to the chisels, gouges, and scorpers of the carver.

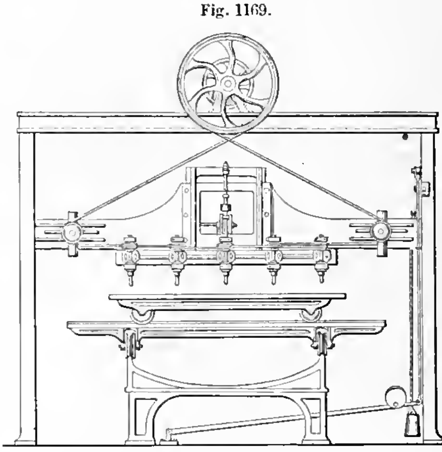
As early as 1800, a Mr. Watt, of London, built a machine that carved medallions and figures in ivory and ebony, producing some very handsome work with great rapidity; in 1814 and 1815, Mr. John Isaac Hawkins, of the same city, produced a similar machine for the same purposes; in 1828, a Mr. Cheverton built a machine for similar purposes, the operations of which attracted considerable attention throughout Europe.

BRAITHWAITE's carving process (English), November, 1840. This process is not dependent upon cutting-tools, but the wood is burned away, or rather converted into charcoal. The wood is steeped in water for about two hours, and the cast-iron die, or mold containing the device, is heated to redness or sometimes to a white heat, and applied against the wood, either by a handle, as a branding-iron, by a lever, or by a screw-press, according to circumstances. The molds are cast from plaster casts of the original models or carvings.

The saturation of the wood with water prevents its ignition. It gives off volumes of smoke, but no flame, the wood being charred. After a short time, the iron is returned to the furnace to be reheated, the blackened wood is well rubbed with a hard brush to remove the charcoal-powder, which, being a bad conductor of heat, saves the wood from material discoloration. Before the reapplication of the iron the wood is again soaked in water, but for a shorter time, as the wood now absorbs water with greater facility.

The rotation of burning, brushing, and wetting is repeated 10 or 20 times, or more, until, in fact, the

Fig. 1169.



Carving-Machine.

wood fills every cavity in the mold, the process being materially influenced by the character and condition of the wood itself, and the degrees in which the moisture and heat are applied. The water so far checks the destruction of the wood, or even its change of any kind, that the burned surface, simply cleansed by brushing, is often employed, as it may be left either of a very pale or deep brown, according to the tone of color required, so as to match old carvings of any age; or a little scraping removes the discolored surface.

Perforated carvings are burned upon thick blocks of wood and cut off with a circular saw.

In the machine (Fig. 1169) several copies are carved at once, the pattern being placed midway between them. The model and the wood for the copies are placed, say, 8 or 10 inches apart, on a rectilinear slide, free to move in one direction upon a carriage, which is free to move in a direction at right angles to the former. This forms what is called the *floating-table*, as by a combination of the two motions any direction may be attained. The two movements of the table are under the control of the two hands of the workman while he controls a third slide with his foot. The third slide, which is vertical to the other two, carries in the center a tracer of globular form, and also, at 8 or 10 inches on the right and left of the tracer, cutters of the same globular form, which latter are set to make about 6,000 revolutions per minute. The third slide, which, together with the tracer and side-cutters, forms one entire mass, descends upon the wood with a moderate pressure, that sends the side-cutters into the two blocks of wood until the central tracer rests in contact with the model; the cutting then ceases, and the slide is raised from the work by the treadle.

In this manner, by a multitude of vertical incisions at different parts, the whole surface of the blocks beneath the cutter is removed to a depth corresponding to the exact shape of the model. For expedition, a horizontal motion is imparted to the bed-plate moving the wood against the cutters; the depth at any point being determined by the contact of the tracer with the model. The necessary conditions are, that the tracer and cutters be alike in form and size, and that the distance between them, and also the distance between the model and copies, whether 8 or 10 inches, or any other measure, be preserved throughout the one process.

The above case, in which the work lies horizontally, is that most usually required; but when the work has to be carved on all three sides, — as, for example, in brackets or consoles projecting from a wall, — although the arrangement of the central tracer and the cutters parallel therewith, partaking of a vertical motion in common, be preserved, the model and copies are all three adjusted so as at one time all to lie on their backs, at other times on their right and left sides, with the progress of the work. Sometimes this change is effected simultaneously by mounting them on platforms that are situated on fixed parallel and equidistant axes, and shifting all three at one movement, by a simple arrangement derived from the ordinary parallel rule with radius-bars.

In case of figures carved in the round, or on every side, the central model and two copies are built above one wide bar, upon three circulating pedestals or turn-plates, with graduations or detents, by which the three objects may be alike twisted round to face any point of the compass; and as the wide bar upon which the three circulating pedestals are built has a tilting motion by which the three pedestals may be all alike placed either horizontally, or inclined to the right or left, in any degree, until nearly vertical, it is clear that these two directions of motion constitute universal joints, and enable any and every similar part, of all three objects, to be presented to the tracer and cutters respectively.

The machines are used for wood, soft stone, marble, and alabaster.

The Blanchard machine for turning irregular forms has been used for turning lasts, spokes, axe-handles, gun-stocks, busts, etc., and in some of its applications may be termed a carving-machine. It differs from those just described in the circumstance that the object to be turned is rotated, constituting the machine a true *lathe*, while the revolving cutter is drawn out or in by means of a revolving pattern. The variations of detail will be mentioned under LATHE (which see).

Carv'ing-ta'ble. A table heated with hot water, in which are depressions forming pans to hold joints of meat.

Car-wheel. One adapted for the uses of cars, or the trucks of railway cars.

They were originally like those in ordinary use, and were guided by *flanges on the rails*, as in the case of the Sheffield Colliery Railroad, 1767. At this time the rails were of cast-iron.

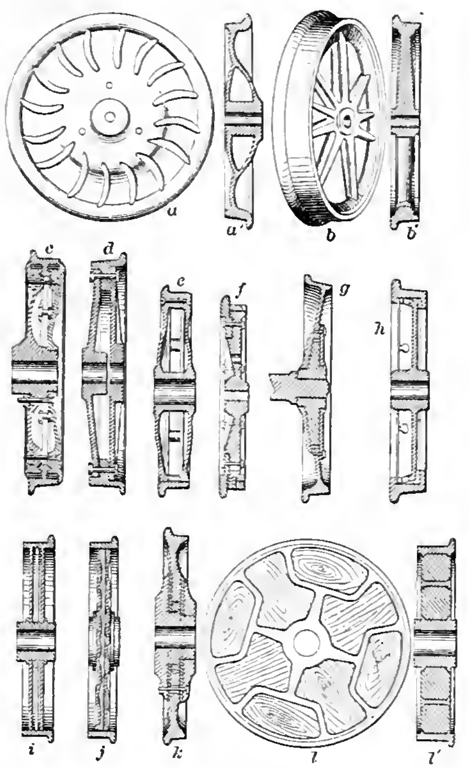
In 1789, car-wheels were made with flanges, to run on the *edge-rail*, which was first made of cast-iron and used at Loughborough, England.

In Stephenson and Losh's patent, 1816, car-wheels were made with wrought-iron spokes, the hub and rim being cast on to them. A wrought-iron tire was shrunk on to the rim, and secured in its seat by a dovetailed depression.

In Fig. 1170 are shown a few examples of the numerous inventions of this class.

a a' represent the famous Washburn wheel so familiar to us all. It has an arch at the central

Fig 1170.



Car-Wheels.

portion adjacent to the hub, and the apex of the arch is connected by a curved web with the rim, the junction of the web and rim being strengthened by ribs or brackets. *a* is a side elevation, and *a'* a diametric section.

b b' are perspective and sectional views of a wheel whose hub is connected by spokes with the rim. Such was Stephenson and Losh's, already mentioned; indeed, this is quite an antiquated form.

c is one of the Woodbury wheels, which has a compressed annular elastic packing between the cylindrical faces of the body and rim; the packing being first compressed on the periphery of the body, and the rim then adjusted upon the latter. The body is sectional, having two webs bolted together; one belongs with the hub, and the other is fitted in a rabbet thereon. Each portion has a flanged rim, the combination of the two forming an annular seat for the tire. The interposed packing is intended to absorb the jar.

d is a wheel cast in three separate pieces, consisting of a rim and two portions, each of which latter has a hub and a web, between which the inner flange of the rim is gripped and bolted.

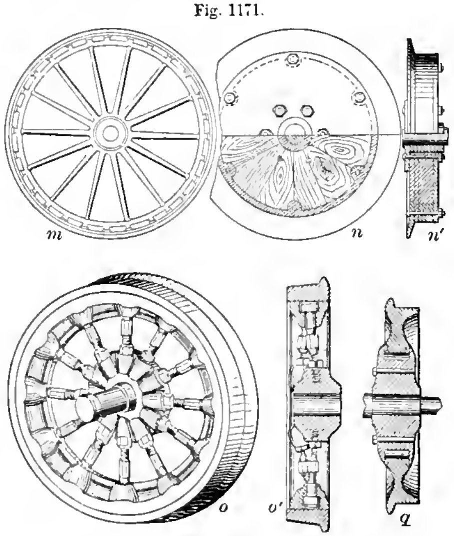
The wheel *e* has side-plates cast in one piece with the hub and cross-pieces, which connect the peripheries of the side-plates. The encircling tire is secured by rivets.

In the wheel *f*, the tire has pins upon its inner side, which enter slots in the rim of the wheel, to hold the tire from shifting. The flange-piece has a shoulder projecting on the inside, that fits in a circular groove in the body of the wheel, to which it is bolted.

The wheel *g* has a circular recess to receive a collar on the axle, over which is bolted a covering annular disk. This device is to allow the revolution of one of the wheels upon the axle in curves of the track.

h is a car-wheel constructed in two parts: first, a rim with two flanges forming an inner recess; and, second, a hub with a web, and flange upon the web,

Fig. 1171.



Car-Wheels.

flaring slightly outward. Slots in this flange (the circumference of which is slightly larger than that of the inner edge of the rim) permit it to spring past the flange of the rim into the inner recess. This device dispenses with the use of bolts, and gives elasticity to the wheel.

i and *j* are two forms of wheel, in each of which the cast hub and rim are connected by corrugated wrought-metal disks.

k is the Raddin wheel, in which the entire web and rim are cast in one piece, and the inner edge of the web rests upon the hub. The hub is formed with supporting flanges or binding rings, which are bolted to each other through enlarged holes in the web, with interposed packing-rings of india-rubber to lessen tremor and jar.

l l' are two views of the Watson wheel, in which the space between the hub and the rim is occupied by a skeleton metallic frame, whose openings are filled with panels of wood compressed therein.

In the wheel *m* (Fig. 1171), wedges of wood are driven between the rim and the tire. The purpose of these, also, is to absorb jar.

n n' are views of a compound wheel in which segments of wood form a web between the hub and the rim, being secured and strengthened by metallic plates.

o o' are views of a wheel in which the hub and rim are of cast-iron united by wrought-iron spokes, each alternate spoke leaning at an angle from opposite sides of the central circumference of the hub to the central line of the rim.

q is a wheel somewhat similar to *k*, in which the web of the wheel is inclosed between binding-plates, and has a packing between itself and the plates, and also on its inner edge.

Paper also enters into the composition of some car-wheels. The paper is tightly pressed in as a packing between the steel tires and the cast-iron hubs, so as to form a compact, strong, and yet somewhat resilient, material, which deadens sound and diminishes the force of concussion.

"There are in daily use, on the 37,000 miles of railway in the United States, not less than 1,250,000 truck and car wheels, under 8,500 locomotives, 6,500 passenger-cars, 2,700 baggage and express cars, and 160,000 freight-cars.

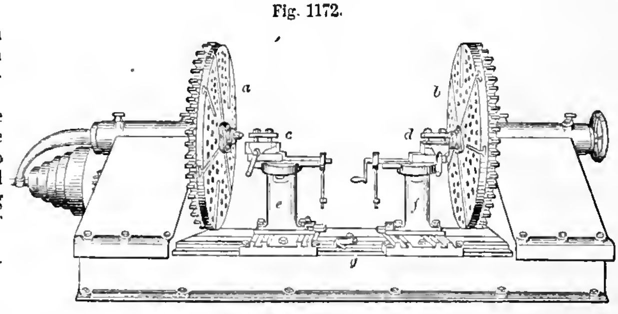
"The available statistics show that passenger-cars make an annual mileage of 28,400 miles, or 88$\frac{75}{100}$ miles per day of 320 days per annum; the average load borne on each car-wheel to be 3½ tons. With this load the average life of a wheel is 45,000 miles, or 1$\frac{58}{100}$ years. On trains running at express speeds, the average life does not exceed 10 months' service, while wheels under tender-trucks have a life of 18 months. Under freight service in the State of New York, with an annual train-mileage of 11,483,123 miles, transporting 75.5 tons of freight per train, the annual mileage per car was 14,649 miles, each wheel bearing an average load of 1.47 tons, which gives 3.08 years as the life of a freight-wheel, corresponding with the experience of one of the principal roads in the State.

"But, assuming the average life of car-wheels, under all kinds of service, to be five years, the total number of wheels worn out annually in the United States will not be less than 250,000.

"At an average cost of eighteen dollars per wheel, allowing about one half for the value of the old wheel, the annual loss may be stated at two and a quarter millions of dollars." — W. G. HAMILTON.

Car-wheel Fur'nace. One in which cast-iron car-wheels are heated, and then cooled slowly, so as

Fig. 1172.



Car-Wheel Lathe.

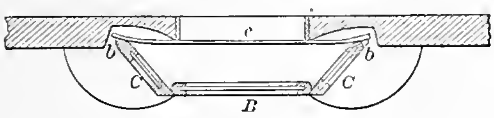
to anneal them, and render them less brittle. See ANNEALING-FURNACE.

Car-wheel Lathe. One which is adapted for turning off the rims of two driving-wheels after they have been pressed on to the axle; or for turning off the wheels separately. *a b* are the face-plates, 8 feet 6 inches apart, and forming head-stocks separately geared and independently driven, if desired. *c d* are the tools mounted in the slide-rests *e f*, which are adjustable on the bed *g*.

Car-win'dow. (*Railway.*) Car-windows are usually arranged to lift, and, being light, have no counterpoises.

Ventilating car-windows are made to open at the side towards, for the time being, the rear of the car,

Fig. 1173.



Car-Window.

so as to cause an induced draft from the interior by the rushing past of the air when the car is in motion.

The frame of the window projects sufficiently far from the body of the car to admit of there being applied to it, on each side, a valve or side window *C*, which can be opened or closed as desired, and retained in either position for the purpose of ventilating the car.

The side windows *C* vibrate on hinges at *b*, and are retained in position by the spring *c*, either open or closed against the front window *B*.

Car-win'dow Fast'en-ing. A spring-bolt which holds a car-window sash at any required elevation, according to provision of holes in the casing for the reception of the bolt.

A cam or snail-shaped piece secured to the face of the sash, and binding by the weight of the same against the beading, to hold the sash at any elevation.

Car'y-at'i-des. (*Architecture.*) Female figures placed as columns to support an entablature. Male figures in this position and relation are called *Atlantes*, *Telamones*, or *Persians*.

Cas'ca-bel. (*Ordnance.*) The rear portion of a gun, embracing the *knob*, *base*, and *base-ring*. The *cascabels* of ships' guns have *breeching-loops* in place of knobs, intended for the *breeching*, whose ends pass to ring-bolts on each side of the port, and whose duty is to limit the recoil.

Cas-cade'. A pyrotechnic device to imitate sheets or jets of water. Chinese fire is used.

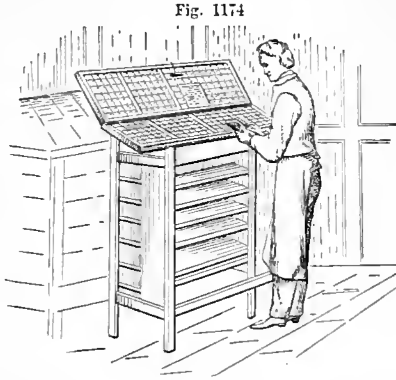
Case. 1. (*Printing.*) Types are arranged in a *case*, which is a tray with compartments for the letters. Two pairs of *cases* are allowed to a compositor, and constitute a *frame*; one pair contains Roman letters, and the other italics.

The sizes of the compartments are unequally proportioned, as some letters occur more frequently than others. It is also designed to place those compartments most frequently resorted to nearest to the ordinary position of the hand, so that expedition may be secured. The proportion of English letters in a case is as follows: —

a, 8,500	e, 12,000	i, 8,000	m, 3,000
b, 1,600	f, 2,500	j, 400	n, 8,000
c, 3,000	g, 1,700	k, 800	o, 8,000
d, 4,400	h, 6,400	l, 4,000	p, 1,700
q, 500	t, 9,000	w, 2,000	z, 200
r, 6,200	u, 3,400	x, 400	See FONT.
s, 8,000	v, 1,200	y, 2,000	

The lower case, as arranged for an ordinary work in English, has 54 boxes of different sizes; these contain the various small letters (hence styled "lower-case letters"), the marks of punctuation, the fig-

Fig. 1174



Printer at Case.

ures, and spaces and "quadrats" of different sizes. The upper case has 98 boxes of uniform size. These contain the capitals, small capitals, and various characters which are in frequent use, such as parentheses, stars, and other signs of reference, dashes, dollar and pound marks, and so on.

In the upper case the letters are arranged in alphabetical order in the lower rows, the capitals on the left, the small capitals on the right. In the lower case the letters are not arranged in alphabetical order, but in such a way as to bring those most frequently used directly in front of the compositor. To get a *j* or *z* the hand of the compositor must pass over a space of nearly three feet, while to get a *t* or *e* it traverses only three or four inches. If the letters were arranged in alphabetical order, the work of composition would be at least doubled.

Fig. 1175

Upper and Lower Case.

Besides these usual sorts, there are many others not unfrequently employed, such as accented vowels, superior figures ([1 2 3] etc.), superior letters ([a b c] etc.), fractions, and many others, about a hundred in all. These are usually kept in a separate case.

2. (*Bookbinding.*) A cover made ready for its contents, — the book.

3. (*Masonry.*) An outside facing of a building, of material superior to that of the backing.

4. (*Joinery.*) *a.* An inclosing frame; as, the sash-casing; a hollow box on the sides of the frame, in which the weights work.

b. The frame in which a door is hung. *c.* The inclosure of a stair.

5. (*Weaving.*) The pulley-box of a button-loom.

6. (*Pyrotechnics.*) The paper cylinder or capsule of a firework.

7. (*Mining.*) A small fissure which lets water into the workings.

Case-bay. (*Carpentry.*) The space between a pair of girders or two principals of a roof or ceiling.

Case-hard'en-ing I'ron. A process of cementation which converts the surface of iron to steel. It differs mainly from the manufacture of true steel in the different lengths of time employed, and in the depth to which it extends. Case-hardening is effected by packing the article to be hardened in a box with charcoal, ground or broken bones, particles of horns, rawhide, or tanned leather. The closed box with its contents is placed in an enveloping fire in a furnace. The fuel is preferably charcoal. The longer the heat is kept up, the deeper will be the action of the cementing materials. This process is lengthy, and not always convenient. Frequently all the mechanic requires is a thin coating of indurated metal on the outside of the article, which will not be subject to ordinary abrasion or the action of a file.

A simple method of case-hardening small cast-iron work is to make a mixture of equal parts of pulverized prussiate of potash, saltpetre, and sal-ammoniac. The articles must be heated to a dull red, then rolled in this powder, and afterwards plunged into a bath of 4 ounces of sal-ammoniac and 2 ounces of the prussiate of potash dissolved in a gallon of water.

Sheehan packs a layer of limestone in the bottom of the box, and then layers of a composition alternating with and inclosing the iron to be steelified. The composition is, — charcoal saturated with water, 200; chloride sodium, 30; sal soda, 12; pulv. rosin, 5; black ox. manganese, 5; mixed. Lute on the top, heat, remove while hot, and plunge into cold water.

Case-knife. A large table-knife. It was formerly kept in a case or sheath, and the name is a remembrance of the good (?) old times when every guest carried his own knife to the feast, helped himself from the joint, was innocent of forks or napkins, and finished by using it for picking his teeth or settling accounts with his neighbor after picking a quarrel.

"Many were the tables [at the London Lord Mayor's feast, 1663], but none in the hall but the Mayor's and the Lords of the Privy Council that had napkins or knives." — PEPYS.

"The food of the Celtæ consists of loaves of bread and meat floating in the broth, broiled on the coals or roasted on spits. They grasp the meat in both hands, but in a cleanly manner, and gnaw at it like lions; if any part is too tough to be torn, they draw their case-knives, with which each is provided." — POSIDONIUS; quoted in the "Deipnosophists" (A. D. 220).

"Their platters are of earthenware, silver, brass, wood, or basket-work." — IBID.

Case-lock. A box-lock screwed on to the face of a door.

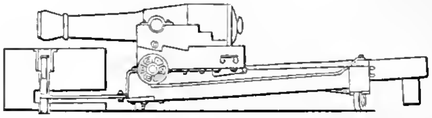
Case'mate. 1. (*Fortification.*) A vault of mason's work in the flank of a bastion or elsewhere in a fortification.

Casemates with embrasures are *defensible casemates. Barrack* and *store casemates* are bomb-proofs for shelter and supplies.

2. (*Joinery.*) A small hollow molding or cove, equal to about ¼ to ⅙ of a circle. See MOLDING.

Case'mate-gun. A gun is mounted in casemate when it is placed in a protected chamber and fires

Fig. 1176



Casemate-Carriage.

through an embrasure. The construction of the carriage differs somewhat from that of the barbette.

Case'mate-truck. (*Vehicle.*) A truck for transporting guns, etc., in casemate galleries or through posterns. The bed consists of two longitudinal rails forming the sides of the body, united by three transoms. The whole rests on four wheels or rollers of cast-iron, and is guided by means of a tongue.

Case'ment. A sash or glass frame opening on hinges and revolving upon one of the vertical edges. A *French* window.

Case-pa'per. The outside quires of a ream.

Case-shot. *Case-shot*, or *shrapnel*, as they are frequently termed, from the name of the English officer by whom they were introduced, about 1808, are a thin species of shell filled with bullets, and having a fuse which is so cut or arranged as to burst the case about sixty yards in front of the object fired at, so as to scatter the bullets over a considerable space. This, under favorable circumstances, is a very efficient projectile, and would be still more so were it possible to cut the fuse to such exactness as to always explode just at the desired point. The shot are sometimes placed in a tin cylinder with a wooden sabot, and used without a fuse at ranges of 300 yards. This is distinctively known as *canister*.

Case-wind'ing Watch. Theurer, of Switzerland (United States patent, February 6, 1866), has a watch so constructed that the opening of the cover winds up the works. It cannot be overwound.

Guizot, April 12, 1870, rotates the case on its pintle, to wind the watch.

Case-work. (*Bookbinding.*) A book glued on the back and stuck into a cover previously prepared.

Cash'er-box. (*Glass-manufacture.*) A table covered with coal cinders, on which the globe of glass is rested while the blowing-tube is detached and a rod attached to the other pole of the globe, preparatory to *flashing*. See CROWN-GLASS.

Cash'mere. (*Fabric.*) *a.* A fine shawl fabric formerly made only in the valley of Cashmere, but now made in many parts of the Punjab. The best are yet made in Cashmere. It is made of the downy wool of the Thibet goat, dyed in various colors before weaving.

Several accounts have been given of the process adopted by the natives in weaving the shawls. It is sometimes woven in comparatively narrow strips, which are afterwards joined. The figures are put in by the shuttle in those of superior quality, and by the needle in those of a lower description. It appears that the waters of a canal flowing from the

Lake of Cashmere have something to do with imparting the peculiar softness to the fabric.

The process is extremely slow; one account states that a single shawl occupies three men for six months. Another account states that the plain shawls only are worked by the shuttle, and the colors are all inserted by needles through the shed of the warp, a separate needle being used for each color. The work is passed through a number of hands, as customary in that old country; the merchants buying the yarn and employing weavers, who receive from 3 to 24 cents a day. The overseer of a shop receives the latter handsome amount, from which he boards himself. Eighty thousand shawls are supposed to be about the annual produce of the kingdom.

Cashmere shawls made from the imported wool of the goat are made in Paris, Lyons, and Nismes. The Jacquard loom is used, drawing the colored threads to the surface as required. The colored threads floating at the back of the shawl in the intervals of their appearance on the face are subsequently cut off, and the cut ends reveal the imitation.

A French loom has been invented for the purpose of avoiding this difficulty and making both sides alike. The yarns of the weft are not only equal in number to the colors of the pattern, but separate bobbins are provided for each repetition of a color across the shawl. Each bobbin or *pirn* stops at the end of the figure, and returns on its track after crossing the track of the adjoining bobbin. Thus the weft is made up of an interlocked series of threads, each occupying a short portion of the length of the weft, according to the limits of its figure in the general design.

The Hindoo shawl, so called, is made in France, of a *silk* chain, and *cashmere-down* filling.

In other varieties, the weft is silk and down; and at Nismes, spun silk, Thibet down, and cotton are all worked up together.

b. A woolen and cotton figured dress-goods, named in imitation of the cashmere fabric.

Cash-me-rette′. (*Fabric.*) A lady's dress-goods, made with a soft and glossy surface in imitation of cashmere.

Cas′ing. 1. (*Metal-working.*) The middle wall of a blast-furnace. Beginning from the inside, we find, the *lining*, *stuffing*, *casing*, and *mantle*. See BLAST-FURNACE.

2. (*Shipbuilding.*) The cylindrical curb around a steamboat funnel, protecting the deck from the heat.

3. (*Blasting.*) A wooden tunnel for powder hose in blasting. *Hose-trough; auget.*

Cask. 1. A large wooden vessel made of staves held together by hoops, and having heads retained by grooves in the interior perimeter of the cask, near the chines.

Casks are of various proportions and shapes. The larger are known by specific names, as the vats and tuns of the brewer and distiller; smaller are the pipes, butts, puncheons, and hogsheads for wine, etc.; smaller still is the barrel, which has almost superseded in the United States all other kinds of casks for the commercial transportation of liquids, such as whiskey, petroleum, vinegar, etc. Least are kegs and drums. A cask knocked down, and the staves and headings bundled and hooped, is known as a *shook*.

The wood for casks is sawn into lengths, and these into narrower pieces, called *codlings*. These are *listed* or hewed to give them a taper towards each end. They are then *cleft* into staves by a *frow* and *maul*. They are then *dressed* to give the convex exterior, concave interior surface. Then *jointed*, which gives the shape to the edges, so that, when drawn in at the *chines*, the staves shall fit closely against each other.

A *splayed* cask is one having a flaring or conical form.

A *bulged* cask is one swelling at the middle.

In the dry climate and with the limited timber of Egypt, casks for liquids were but little used, but some of their dry measures were made of staves and hooped wood or metal.

"The chief freight [of the boats on the Euphrates] is wine, stored in casks made of the wood of the palm-tree." — HERODOTUS, I. 194.

2. (*Dyeing.*) One form of steam-apparatus for steaming cloths which have been printed with a mixture of dye-extracts and mordants, in order to fix the colors. It is a hollow cylinder, within which the cloths are suspended for the application of the steam admitted to the interior of the drum.

Cas′se-gra′ni-an Tel′e-scope. A form of the reflecting-telescope in which the great speculum is perforated like the Gregorian, but the rays converging from the surface of the mirror are reflected back by a small convex mirror in the axis of the telescope, and come to a focus at a point near the aperture in the speculum, where they form an inverted image, which is viewed by the eye-piece screwed into the tube behind the speculum. See TELESCOPE.

Cas′si-mere. (*Fabric.*) A single-width men's woolen goods, twilled and oil-finished. *Kerseymere* is probably a corruption. *Kersey* is a local name for a coarse worsted cloth of Scotland and Ireland.

Cas′si-nette. (*Fabric.*) A cloth made of a cotton warp and a weft of fine wool or wool and silk.

Cast. Warped. Said of sprung timber.

Cas′ta-net. A clapping instrument, composed of two little saucer-shaped disks held in the hand and beaten with the middle finger, generally as an accompaniment to the dancing of the player.

These were used by the virgins in the ancient hymns to Diana.

> "They make a noise like castanets."
> HERMIPPUS.

> "Strikes with nimble hand
> The well-gilt, brazen-sounding castanets."
> *Song to Diana*, quoted by DICÆARCHUS.

The Phæacians, in Homer, had a dance in which their figures were accompanied by the bystanders, who made a clapping noise with their forefingers. — ATHENÆUS.

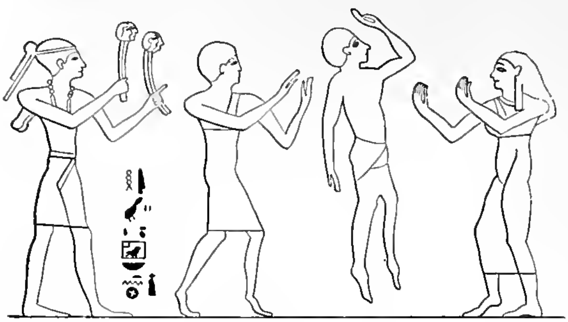
The *crotala*, or wooden clappers, were common in Egyptian musical processions, as were also clapping of hands, cymbals, tambourines, and tam-tams.

The little cymbals played with the finger and thumb in the manner of castanets are shown in the paintings of Herculaneum, and are used in the *Almeh* dance of modern Egypt.

The modern *bones*, which give so much vivacity to the negro minstrelsy, especially the factitious article on the stage, have their ancient and modern analogues in regions and times far remote. Round-headed pegs are seen in the hands of some of the dancing figures in the paintings of Herculaneum, and similar instruments of wood are used by the Japanese. In ancient Egypt a similar effect, without the rapidity of execution, was attained by the maces, which were hollow, metallic, and sonorous, and in the illustration, from which the accompanying cut is derived (a tomb in Thebes), the player is beating time for a group of professional dancers.

The castanets are used in many of the national dances of the countries bordering on the Mediterranean, and the use extends east of this district as far as China. They are used by the bayadeers in India,

Fig. 1177.



Egyptian Maces (from Thebes).

and the professional dancing-girls of Java, who are painted entirely white, and whose performances are rather attitudinizing than dancing; undulatory motions of the body, arms, and head taking the place of the agility of the legs and feet.

The first suggestion of the castanets may have been the practice of snapping the fingers in keeping time, wooden pins being afterwards substituted as being more effective, the players striking their little maces together as they met or crossed in the evolutions of the dance. The castanet, thus originating, became of a festive and votive character, while the heroic cymbal seems to have originated in warlike dances such as the Pyrrhic, Corybantian, and Persian, where swords and shields were struck and clashed in furious imitation of the scenes of war. See CYMBAL.

The mural sculptures of Nineveh show large bodies of men welcoming the king by advancing in military order, clapping their hands in time to the rhythm of the pæan. The attitude of the men forming the platoon reminds one of the modern Shakers.

Dancing was originally of a religious character, and has been introduced into the religious services of all nations and nearly all times. In many countries it is practiced, as a part of the temple services, by professionals only, as the bayadeers of India; or by fanatics, as the dervishes of Moslem lands. In Oriental countries, as also in ancient Rome, it is considered unbecoming the gravity of men, and they regard it absurd for persons who can afford to hire dancers to give themselves so much trouble.

The idea of dancing as a festive entertainment practiced by the guests seems to be European, though some of the pictures of ancient Egypt indicate that the guests danced at their assemblies.

Miriam and her *troupe* of females danced as a votive exercise in celebration of the deliverance at the Red Sea, and used as accompaniments the musical instruments of Egypt.

Without occupying space by citing the saltatorial and posturing exercises of the nations of antiquity, it may be briefly mentioned that in the early centuries of the Christian Church the dance was combined with the hymn. This was, no doubt, a concession to the Pagan habits of the people. Scaliger says that the bishops led the dance, and dancing in churches was common till the twelfth century, and in some Catholic countries till the seventeenth century.

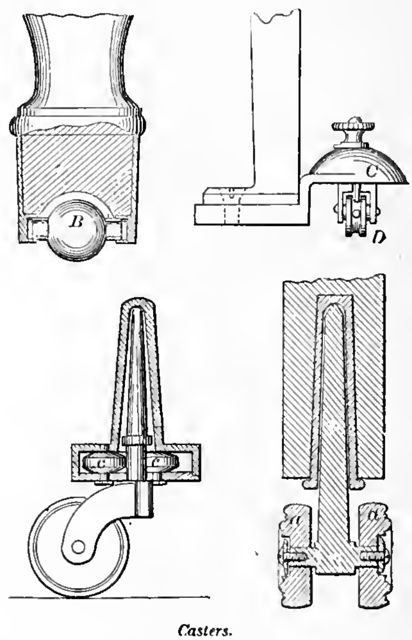
The Mohammedan religion forbade dancing in mosques 1,000 years before it was discontinued in churches. The Koran promises no dancing in Paradise, nor any other active employment. "Repose yourself for a moment," said Derar to Caled; "you are fatigued with fighting with this Christian dog." "O Derar," said the indefatigable Saracen, "we shall rest in the world to come. He that labors to-day shall rest to-morrow." So they fought on by the walls of Damascus.

Cast′er. 1. A small wheel attached to the leg of a table, chair, or other piece of furniture, in order to facilitate its being moved about without lifting.

It turns on a vertical pivot as well as on its axis. It is not easy to determine whether the circular objects beneath the feet of the chair of Rameses III. are casters or merely balls in the grasp of the claws which form the chair-feet. It is in the tomb of the kings of Thebes, and the great Sesostris is represented in his private apartments. The chair is a folding one, the X-legs being pivoted on a horizontal bar at their intersections.

The illustration shows several kinds: a piano-leg caster, having a ball *B* with trunnions; a sew-

Fig. 1178.



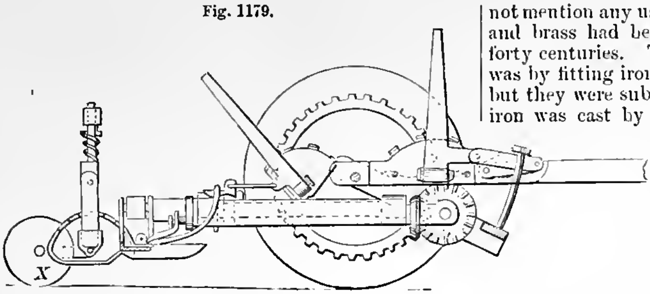
Casters.

ing-machine caster, in which the wheel *D* is attached by a domed bracket *C* to the leg; a table-leg caster having anti-friction rollers *c c*; a caster with a pair of wheels *a a*.

2. A stand to hold cruets.

Cast′er-wheel. This wheel is adapted to rotate on its axis in the stock in which it is journaled, and the stock itself rotates on a vertical axis, according to the direction of propulsion of the carriage or article to which it is attached. The caster-wheel is used as a support to the front parts of machines, such as harvesters, gang-plows, spading, digging, excavating, and plowing machines, to enable them to be steered or to turn short around at the end of the

Fig. 1179.



Caster Wheel.

row. The illustration shows the caster-wheel *X* at the forward end of a harvester.

Cas-til'ian Fur'nace. (*Metallurgy.*) A lead-smelting furnace invented by Goundry (English), but first used in Spain. Its chief peculiarity is the arrangement for running off a constant stream of slag for future treatment, the slag running into cast-iron wagons, which succeed each other as their predecessors become filled. — URE, Vol. III. pp. 689-692 (Am. ed.).

Cast'ing. Scattering references to the casting of metals are found in the Greek writers. The paintings and sculptures of the Egyptian tombs have failed to throw any light upon the subject of the process. A multitude of cast bronze figures are in the European collections, and in the Abbott Collection of the N. Y. Historical Society, New York City. It is probable that the shaping of metal by the hammer, chisel, and graver preceded that of casting into molds of specific form. Pausanias declares that statues beyond the reach of the smith's art were made piecemeal and the portions fastened together. He supposes the statue erected by Ulysses to Neptune to have been thus constructed. He ascribes the art to Rhœcus and Theodorus, of Samos, in the time of Polycrates (555 B. C.), the patron of Pythagoras and Anacreon.

Bronze castings of Egyptian and Etruscan workmanship, and of great antiquity, are found, but are not identified with any date. The bronze statues of both nations, in all probability, antedate the foundation of Rome, 753 B. C.

The casting of the bronze vessels and ornaments for the service of the Temple at Jerusalem was about 1004 B. C., and took place in the clay ground between Succoth and Zeredatha. This is far more ancient than the Grecian annals, and the calf-idol cast by Aaron was five hundred years earlier still. It was an old art in Egypt.

With the exception of the statues of cast-iron referred to as mentioned by Pausanias (about A. D. 120), and regarded as curiosities, the ancients seem to have had no knowledge of the uses of cast-iron. It was regarded as in a transition stage, and was destined to be made malleable by continuous processes of heating and hammering. Pausanias says: "The temple of the Great Mother at Sparta is said to have been built by Theodorus the Samian, who first discovered the art of casting iron and making statues of it." "At Delphi is dedicated a Hercules and Hydra, both of iron. To make statues of iron is most difficult and laborious, but the work of Tisagoras, whoever he was, is really admirable. In Pergamus are the heads of a lion and a boar, both of iron." Theodorus is understood to have lived in Samos before it was merged into the Greek Empire, which took place when it was conquered by Athens, 440 B. C. A work on iron and steel written in 1550 does not mention any use for cast-iron; castings in bronze and brass had been known and used for certainly forty centuries. The early mode of making cannon was by fitting iron bars together and hooping them, but they were subsequently cast of bronze. British iron was cast by Ralph Page and Peter Baude in Sussex in the year 1543.

In 1612, 1613, and 1619, patents were granted in England for the use of coal in iron-casting. The first two were unsuccessful, and the last would appear to have been successful, as it provoked the usual results, — a mob tore down the establishment. The writer does not recollect any account of the tearing down of a shop where a supposed perpetual-motion engine was domiciled.

Emmanuel Swedenborg, in his "Regnum Subterraneum" (1734), credits the English workmen with the first successful casting of iron cannon at various foundries in Kent and Sussex. Workmen from these parts carried the art to Perigord in France. The only use for iron castings at that time was for ordnance.

Members of the Society of Friends started ironworks at Coalbrookdale, in Shropshire, England, early in the eighteenth century. Their religious principles forbade their casting cannon, and they devoted their metal to peaceful usages and equipments; casting fire-grates, boilers, and numerous articles of medium size. Many difficulties seem to have beset the workmen, in regard to the making of flasks, the selection of a suitable loam and parting; and the eventual success is connected with a pleasing episode in the history of mechanical industry, which is substantially as follows: —

About 1709, Abraham Darby, of Bristol, had a Welsh boy in his service named John Thomas. The master had been endeavoring to cast iron with but indifferent success, and the boy stated that he saw through the difficulty. They stayed after the workmen had left, and cast an iron pot in a mold of fine sand with a two-part flask, and with air-holes for the escape of steam, etc. From 1709 to 1828 a business partnership was maintained in the persons of themselves and their descendants, and the process is stated to have been kept secret at Coalbrookdale till about 1800. From the terms of the account, it would seem to have been hollow-ware that particularly bothered them; and no one who is acquainted with the art of casting iron-ware of that description will wonder at the difficulties that attended the first attempt, or withhold the meed of praise due to the success of the man and his boy.

An Abraham Darby erected the first iron bridge in 1777; it spanned the Severn near Coalbrookdale with a single arch. It is believed that at these works coke and coal were first successfully used in smelting iron.

Very small iron castings are made at Berlin, Germany, known as the Berlin iron ornaments and chains. One exhibited in London was 4 feet 10 inches long, had 180 links, and weighed $1\frac{5}{8}$ ounces.

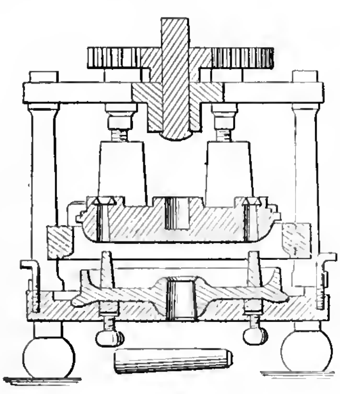
Professor Ehrenberg, the renowned microscopist, states that the iron of which they are composed is made from a bog iron-ore, and that the sand is a kind of tripoli, also containing iron. Both are composed of the remains of animalcules.

The origin of these interesting works of art was during the struggle between Prussia and France under Napoleon I. The generous ladies gave up their jewels to purchase the necessary armaments, and received in return iron ornaments which bore the inscription, *Ich gab Gold um Eisen*, — "I gave gold for iron."

An anvil block weighing 280,000 pounds, to be used with a 44,800-pound double-action forge-hammer was cast at Newcastle-upon-Tyne.

To obtain the best result in compact metal-castings, destitute of porosity and with sharp definition on the angles and ornaments, *casting under pressure* has been devised. See Hollingrake's English patent, 1819.

Fig. 1180.



Casting-Machine.

In one case the molds are so arranged that the top part serves as the follower of a press, and is operated upon by screws. The top fits closely into the matrix, and is provided with ingates for the metal, which are closed by slides when the mold is full. The pressure is applied to the metal while in a melted state, by means of the screws, with sufficient force to expel the air and gas from and solidify the metal.

In Smith's process of compressive casting, the thing to be copied, say a page of type, is placed face upwards on a flat brass plate, and then coated all over with a preparation of potter's clay worked in with a brush. When the whole face of the article to be molded has been covered, the plate carrying it is placed on the bed of a screw-press. A brass box is locked round it, and this box is filled up for about two inches with pottery clay, sifted in and slightly rammed down. The whole is then put under the tympan of the press, and squeezed hard by two men operating the handles of the screw. The box is then opened, and out comes a flat tile with the model still fixed in it. The model is withdrawn by a little suction apparatus of india-rubber, and we have an exact *facsimile* of the model, ready, when dried, to be cast from. Nothing can exceed the beauty of the result produced by the casting of the metal under pressure in the mold thus prepared. Screws and nuts which never had a tool put on them leave nothing to be desired in the way of accuracy and completeness.

In the English patent (No. 3,197, January 28, 1809), the molds for casting are upright and made to revolve on pivots or spindles while the metal is poured in. The centrifugal force causes the metal to fill up all the parts of the mold.

In an American patent of 1857, the car-wheels are revolved so that the first metal poured in is made to form the tread of the wheel, and a second portion to form the body of the wheel.

In Bessemer's patent the metal is poured into a revolving cylinder whose rapid rotation causes it to collect on the inside of the same, when it is allowed to cool. It is then split open and rolled flat.

Castings of great delicacy are produced by using models of wax. These are imbedded in molds made of fine ground earth, which are then heated red-hot. The mold is baked, the wax disappears, and the metal, when poured in, exactly takes its place. The wax model is often made in a gelatine mold, which, being very elastic, will slip off the original object which is to be copied into metal.

With large hollow castings, such as the cylinders of the larger class of low-pressure steam-engines, both the *core* and the *cope* are built up.

For specific index of terms, processes, and appliances in casting, see FOUNDING.

Cast'ing-box. (*Founding.*) A flask containing the mold. See FLASK.

Cast'ing Clay-ware. (*Pottery.*) Delicate objects, which cannot be readily molded by pressing the clay into the mold, are cast by the following process.

The plaster mold being closed, the *slip* or creamy clay is poured in, and the portion nearest to the mold becomes hardened by the absorption of the water by the mold. The fluid portion is then poured out, and the mold partially dried. A second filling of slip yields another coating, and the process is repeated as often as may be necessary to give the required thickness to the casting.

Cast'ing-la'dle. (*Founding.*) An iron vessel with handles for conveying molten metal from the cupola and pouring it into the mold.

Cast'ing-press. One in which metal is cast under pressure, as in the car-wheel press (Fig. 1100, CASTING).

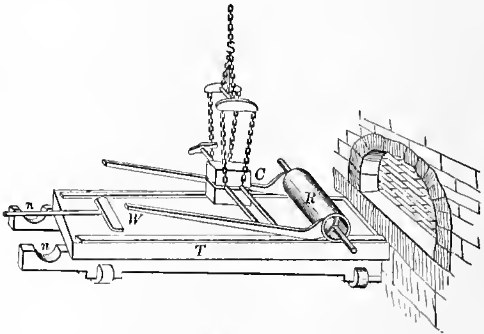
Cast'ing-slab. (*Glass-manufacture.*) The flat piece on which the metal is poured in making plate-glass. The *casting-table.*

Cast'ing-ta'ble. (*Glass-manufacture.*) The table in a plate-glass factory upon which the molten glass is poured from the *cuvette*, and rolled to a thickness by a roller which rests upon the marginal ledges of the table, whose hight determines the thickness of the plate. See PLATE-GLASS.

The table *T* is of cast-iron, perfectly level and smooth, and placed or mounted so that the plate may be delivered into the mouth of an annealing-oven at the same elevation.

The *cuvette C* containing the molten glass is conveyed by a traversing crane from the oven, where its contents have been settling for several hours, and, being brought over the table, is tipped by means of the tongs, so as to spill its contents upon the table. The roller *R* is then set in motion, so as to flatten out the mass of glass. At the sides of the table are ledges, which elevate the roller to a given distance above the table, and thus determine the thickness of the glass. The standing position of the roller is at the far end of the table, as represented; and as it

Fig. 1181.



Casting-Table.

passes forward, it compresses the glass in a wave before it, driving any surplus over the end of the table, where it falls into water. A washer *W* is passed immediately in front of the glass, to clear the table of all impurities. The roller then rests in the grooves *n n*.

The plate is then shifted into the oven, where it remains five days to anneal.

Cast-i'ron. 1. A compound of iron and carbon.

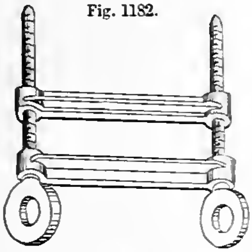
2. Iron run from the smelting-furnace. *Pig-iron.*

3. Iron melted and run into molds. See CASTING.

Cas'tor. (*Fabric.*) A heavy milled cloth for overcoats.

Cas-trat'ing-clamp. Used in confining the chords and vessels in the operating of orchotomy by excision of the parts, as in the case of the horse.

Fig. 1182.



Castrating-Clamp.

"It is a custom peculiar to all the Scythian and Sarmatian tribes to castrate their horses, in order to render them more tractable." — STRABO, VII. v. 1.

The metallic tourniquet-clamp is furnished with set screws and a peculiar pair of lips or guides.

The practice of castrating calves and pigs was usual in Greece.

Athenæus, in the "Deipnosophists," says: —

"And how much better a paunch of a castrated animal is, Hipparchus tells us: —

"'But above all I do delight in dishes
Of paunches and of tripe from gelded beasts,
And love a fragrant pig within the oven.'

"Sopater says in his 'Hippolytus': —

"'But like a beauteous paunch of gelded pig,
Holding within a sharp and biting gravy.'"

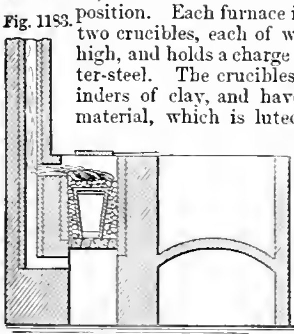
Cast-steel. Blister steel which has been broken up, fused in a crucible, cast into ingots, and rolled.

The blocks of steel are melted in crucibles of refractory clay, and the molten metal is poured into ingot-molds of cast-iron. These are opened, to let out the red-hot ingot, which is then passed to the rolls. See CRUCIBLE; INGOT-MOLD.

The process of making cast-steel was invented by Benjamin Huntsman, of Attercliff, near Sheffield, England, in 1770.

Cast-steel Fur'nace. The furnace has a strong wind-draft, and is lined with a very refractory composition. Each furnace is adapted to contain two crucibles, each of which is about 2 feet high, and holds a charge of 30 pounds of blister-steel. The crucibles stand on short cylinders of clay, and have a lid of the same material, which is luted to the top of the crucible, a little glass being sprinkled on the joint for that purpose. The fuel is coke, and the time occupied in melting is four hours. The heat generated in the cast-steel furnace is said to be greater than in any other manufacture. For some purposes the ingots are made much larger than the weight stated, even as high as 200 pounds. For the heavy forgings, such as the Krupp guns, some hundreds of crucibles are used. Four or five tons of coke are used in melting one ton of steel. Wootz is a cast-steel made from magnetic ore, in crucibles.

Fig. 1183.



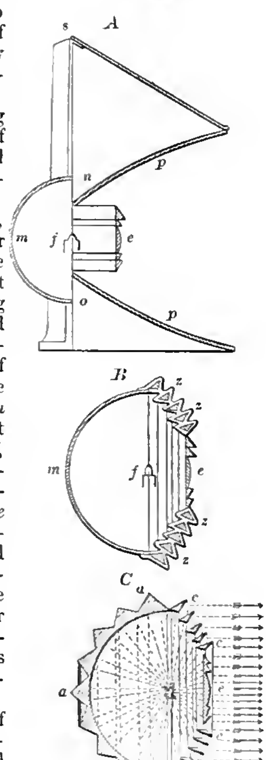
Cast-Steel Furnace.

The crucibles are withdrawn by tongs and grasped by other tongs, lifted, tipped, and emptied into the *ingot-mold*. The pouring is called *teaming*. The mold is opened while the ingot is yet red-hot, and the steel is passed to the rolling-mill. The ingot-mold separates longitudinally, and the parts are held together by collar-clamps and wedges. See CEMENTATION FURNACE.

Cat. (*Nautical.*) The tackle by which the anchor is raised to the *cat-head*. The block is the *cat-block*; the rope, the *cat-fall*.

Cat'a-di-op'tric Light. A mode of illumination for lighthouses in which reflection and refraction are unitedly employed. Suggested by Allan Stevenson in 1834. From their subjecting the whole of the available light to the corrective action of the instrument, they have been called *holophotal* lights.

Fig. 1184.



Catadioptric Light.

The accompanying figures illustrate in brief the main mechanical features of this apparatus.

A is a central section, in which the anterior cone of rays is made parallel by the lens at *e*, and the remaining zone by the paraboloid surfaces *p p*. The posterior hemisphere of rays is received on the hemispherical mirror *m n o*, and by it is sent back to the focus *f*, whence, passing onward, it is in part reflected by the lens *e* and partly by the paraboloid surfaces *p p*, and finally emerges horizontally in unison with the light from the anterior hemisphere. *s* represents one of the struts for supporting the reflecting-plates *p p*.

B is another form of the apparatus, consisting of a hemispherical mirror *m* and a lens *e*, having totally reflecting zones *z z* between them, instead of the paraboloid surfaces *p p* of the other figure.

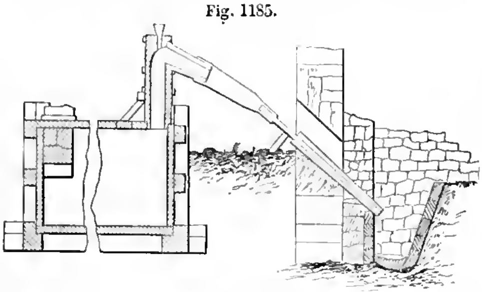
C is another form, in which the hemispherical metallic reflector is replaced by a polyzonal hemisphere, of which each concentric zone *a* has a catadioptric action, like that which is exerted upon rays falling at right angles on the longest side of a right-angled triangular prism. A ray proceeding from the focus falls on the concave or first surface, enters without refraction, is totally reflected at the second surface in a direction tangential to the sphere at the apex of each zone, and, passing on, is again reflected at the third surface, and finally emerges from the opposite end of the inner or concave surface without refraction; whence, passing on through the center of the hemisphere, it becomes a portion of the *anterior* cone of rays, and, being refracted through the lens *c* or reflected by the catadioptric rings *c c*, finally emerges in the paths shown by the *arrows*, and adds its power to the effect of the pencils of rays.

Cat'a-drome. A machine for hoisting heavy weights.

Cat'a-graph. The first draft of a picture.

Cat'a-lan-furnace. A blast-furnace for reducing iron ores, extensively used in the North of Spain, particularly in the province of Catalonia,

Fig. 1185.



Catalan-Furnace.

from whence it derives its name, and whence it was probably introduced into Southwestern Europe.

It consists of a four-sided cavity or hearth, which is always placed within a building and separated from the main wall thereof by a thinner interior wall, which in part constitutes one side of the furnace.

The blast-pipe comes through the wall, and enters the fire through a tuyere which slants downward. The bottom is formed of a refractory stone, which is renewable.

The furnace has no chimneys.

The blast is produced by means of a fall of water, usually from 22 to 27 feet high, through a rectangular tube, into a rectangular cistern below, to whose upper part the blast-pipe is connected, the water escaping through a pipe below.

This apparatus is exterior to the building, and is said to afford a continuous blast of great regularity; the air, when it passes into the furnace, is, however, saturated with moisture.

This apparatus is called a *trompe*. A longitudinal vertical section of the furnace, and of the lower part of the trompe, by which the blast is regulated, is shown in Fig. 1185.

Cat'a-lys'o-type. (*Photography.*) A calotype process in which the paper is first prepared with a syrup of iodide of iron, instead of the iodide of potassium. The name was given to the process to indicate the supposed fact that the gradual self-development of the picture is the result of a catalytic action. The true chemical reaction is now understood.

Cat'a-ma-ran'. (*Nautical.*) *a.* It is formed of logs usually three in number, the middle one the largest, and all secured by three lashings. The logs are slanted for cutwaters, and the raft — for such it is — is sometimes from 20 to 25 feet long and 2½ to 3½ feet wide. They land and push off through surfs, on the Madras coast, which would swamp even the country boats. In moderate weather they carry matting sails by means of an outrigger.

They may be seen on the west coast of South America many miles out at sea, carrying Indians employed in fishing.

b. The incendiary rafts prepared by Sir Sidney Smith for destroying the French flotilla at Bologne, 1804, were called catamarans. The flotilla was constructed for the invasion of England by Bonaparte; the floating carcasses were a failure; but for his own

Fig 1186.

Catamaran

reasons the general broke up his camp and transported his troops to the Rhine. The capitulation of Ulm and the battle of Austerlitz soon followed.

Cat'a-me'ni-al-sack. A receptacle for the catamenia.

Cat'a-pult. An ancient engine for hurling stones or darts. It is usually represented as a cross-bow on a large scale.

Cat'a-ract. (*Steam-engine.*) A regulator invented by Smeaton for single-acting steam-engines.

The *plug-tree* in its ascent draws upon a cord, and lifts a piston in a vertical pump-barrel whose foot is submerged in water; a valve at the foot of the barrel admits the water thereto. The up-stroke having ceased, the piston rests upon the water, and a discharge-valve opens. The rate of discharge is regulated by the load on the piston or the size of the aperture. When the plunger passes a certain point, it makes the changes which readmit the steam, the plug-rod having no effect in so doing, as its connection is flexible. By the means of this device, called a *cataract*, the time of admitting steam is regulated by the flow of a certain quantity of water through an opening, and is entirely independent of the engineer, of the pressure of the steam and other contingencies, provided that sufficient pressure is maintained to run the engine at all.

If the boiler steam be at an unusual tension, the stroke may be made faster, but the interval between strokes depends upon the hydraulic device described. See CORNISH STEAM-ENGINE.

A modification of this is introduced into marine engines for softening the fall of the expansion-valves. A brass cylinder is filled with water or oil, and fitted with a solid piston connected by a cross-head with the valve-spindle. The fall of the valve is checked and regulated by the escape of the water or oil through a small hole bored for that purpose in the side of the cylinder, the piston of the cataract descending according as the liquid is forced out from before it by the pressure due to the weight of the expansion-valve. See CUT-OFF.

Cat′a-ract-knife. (*Surgical.*) A small keen-edged knife used in the operation of removing cataracts by extracting the crystalline lens entirely.

When the opaque body is removed and light admitted for the first time to the organ, the retina receives a new sensation, but much time elapses before the person is able to appreciate form or distance; this is a matter of practice and experience.

Cheselden the oculist gives an interesting account of a person blind from birth and brought to light at a mature age. An account is given in Mark viii. 22–26, of a blind person upon whom a miracle was performed by which he became for the first time sensible of light. Being asked "if he saw aught," he replied, "I see men as trees, walking"; that is, he saw something moving, but had no perception of relative form or distance, whether the object was a man or a tree, near or distant. A second and more wonderful miracle (v. 25) gave the eyes their functional power, the nerves and brain the true perception of the image on the retina. This was beyond the skill of the oculist.

A successful operation for cataract was performed, in the 25th Nivose (January 14), 1799, in the Hospice des Villards, Paris, on a man aged twenty-four, born blind. The operator was Citizen Fortenze, according to the affected style of the day.

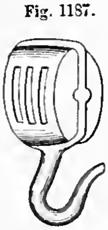
Cat′a-ract-nee′dle. (*Surgical.*) A pointed instrument used for depressing the crystalline lens in the operation of couching.

Ca-tarrh′al-syr′inge. A nasal irrigator or douche as a remedy for or alleviator of catarrh.

Cat-beam. (*Shipbuilding.*) The longest beam in a ship. The *beak-head* beam.

Cat-block. (*Nautical.*) A two or three fold block, iron-bound, with a large iron hook attached to it, employed to draw the anchor up to the cat-head. On the forward side of the shell of this block are two small eye-bolts, for the purpose of fitting a small rope, called the back-rope bridle, used in hooking the cat.

Fig. 1187.



Cat-Block.

Catch. A spring bolt for hinged doors or lids.

Catch-bar. (*Knitting-machine.*) A bar employed to depress the *jacks.*

Catch-ba′sin. A cistern at the point of discharge into a sewer, to catch heavy and bulky matters which would not readily pass through the sewers, but which are removed from time to time. The catch-basin in the example has several receptacles, which combine to fill the space, and are separately removable, to assist in the discharge. The central cylinder is shown in the position of being raised.

Catch-bolt. A cupboard or door bolt which yields to the pressure in closing and then springs into the keeper in the jamb. Usually retracted by a small knob.

atch-fe3d′er. (*Hydraulic Engineering.*) An irrigating ditch.

Catch′ing-hook. A crochet-hook.

A crook or animal-catching hook.

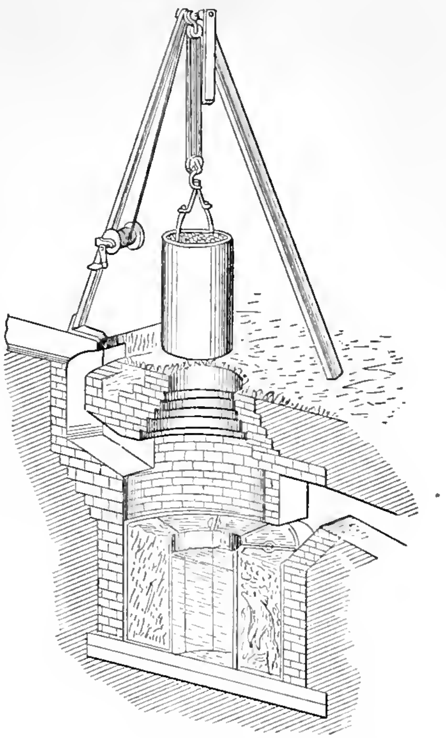
Catch-mo′tion. (*Machinery.*) A motion in a lathe by which speed is changed.

Catch-wa′ter Drain. A drain to intercept waters from high lands, to prevent their accumulation upon lower levels.

Water thus intercepted and carried off may have an effective and rapid fall to the outlet, whereas, if it were allowed to find a lower level, it might require the aid of machinery to lift it to get rid of it.

This plan of intercepting water also lessens the extent of an inundation.

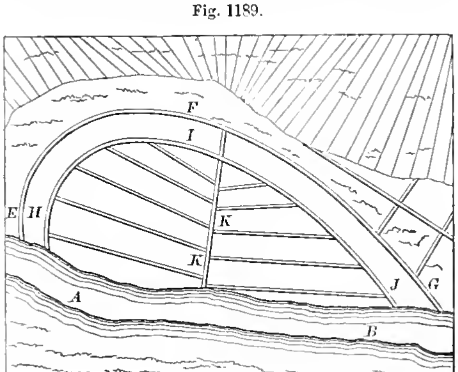
Fig. 1188.



Catch-Basin.

In the illustration, *E F G* is the *catch-water drain.* *H I J* is a parallel main drain. *K* a main drain, into which the smaller ones empty. *A B* the river.

Fig. 1189.



Catch-Water Drain.

Catch-work. (*Hydraulic Engineering.*) A water-way for flooding artificial meadows.

Cat′e-lec′trode. The negative pole of a voltaic battery.

Cat′e-na-ry. The curve assumed by a cord, wire, or chain, hanging freely between two points of suspension.

Galileo suggested that it was the proper figure for an arch of equilibrium. In this the great Florentine, as usual, was correct.

It is now universally adopted in suspension-bridges. Each wire assumes its own catenary curve, and the cable is formed of bunches of aggregated strands.

Formerly they were made to form arcs of circles.

Cat-fall. (*Nautical.*) The tackle by which the anchor (by its ring) is suspended from the *cat-head* in hauling up.

Cat'gut. Twisted intestines of animals. Those of the poor Italian sheep are preferred to those of better-fed animals of other countries.

The guts, taken warm from the animal, are cleaned, freed from adherent fat, and rinsed in pure water. They are then soaked for two days, scraped with a copper plate having a semicircular notch, beginning at the smaller end. This removes the mucous and peritoneal membranes. The guts are then soaked, again scraped, washed, steeped in weak lye (two ounces to the gallon), passed through a polished hole in a piece of brass, to equalize the surface, twisted, dried, and sorted. They may then be dyed or sulphured, and rubbed with olive-oil.

Catgut is used for violin and harp strings, as whip-cord, bow-strings, clock-cords, lathe-cords, etc.

Other guts are used for coarse purposes. Horse guts are split into four, cleaned, twisted, etc., for lathe-bands.

Strong catgut is made of a number of strips of gut twisted together. By another process the clean gut is *blown*, dried in the open air or under sheds, and then compressed, moistened, sulphured, and twisted.

Cath'a-rine-wheel. (*Pyrotechnics.*) A form of firework having a spiral tube which rotates as the fire issues from the aperture. A pin-wheel.

Cat-harp'ing. (*Nautical.*) One of the ropes by which the shrouds are drawn towards the mast below the tops, to allow the yards to swing clear when close-hauled.

Iron cramps are now usually employed, still, however, retaining the name.

Cat-head. (*Shipbuilding.*) *a.* An inclined timber projecting from the bow of a ship, forming a crane-arm from which the *bower anchor* is suspended when raised from the water.

The tackle used in *hauling-up* is called the *cat-fall*, and is hooked to the ring of the anchor.

In preparing to *let-go*, the anchor is suspended from the *cat-head* by means of a rope called the *cat-head stopper*. See ANCHOR-TRIPPER.

The inner end of the *cat-head* is made fast to a beam or frame, and is termed the *cat's tail*.

The sheaves for the *cat-fall* run in mortises in or near the outer end of the *cat-head*.

b. (*Mining.*) A miner's name for a small capstan.

Cat-head Stop'per. (*Nautical.*) The rope or chain by which the ring of an anchor is secured to the cat-head. A device for casting it loose and thereby freeing the anchor is an ANCHOR-TRIPPER (which see).

Cath'e-ter. A tube which is introduced through the urethra, to evacuate the contents of the bladder.

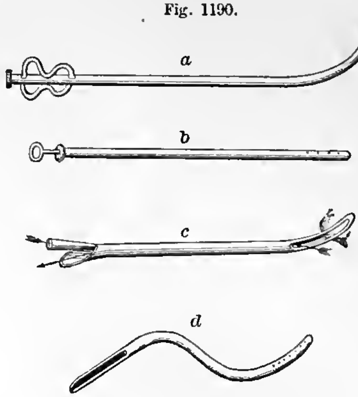
They are specifically adapted (*a*, *b*) for male and female patients.

Some are adapted for the introduction of caustic, constituting a *porte-caustic*.

Catheters are also employed to enter the canal which connects a cavity in the ear with the back part of the mouth, and called the *Eustachian tube*, after its discoverer, a learned Italian physician who died at Rome, 1574.

A double catheter (*c*) is one whose outer tube has a long eye and an inner tube of smaller size, which discharges about the middle of the length of the eye of the larger one. If water be injected through

Fig. 1190.



Catheters.

the inner tube, it enters the cavity of the uterus or bladder, as the case may be, and passes out through the outer canal.

d is Sims's sigmoid catheter of hard rubber.

Male and female catheters are described particularly by Celsus, first century A. D., and have been disinterred at Pompeii. One is of the modern sigmoid form; and one is shorter, and has a single curve.

Cath'e-ter-gage. A plate with perforations of a graduated size, forming measures for diametric sizes of catheters.

Cath'e-tom'e-ter. From Greek words meaning a measurer of vertical hight. A telescopic leveling-apparatus which slides up and down a perpendicular, graduated, metallic standard. As the column of liquid rises or falls in the tube, the telescope partakes of the motion, and the differences of hight are shown on the graduated standard.

Cath'ode. That pole of the battery by which the electricity passes out of the substance undergoing decomposition. The negative or — (minus) pole. (Professor Faraday's term.)

Cat-hole. (*Shipbuilding.*) One of the holes above the gun-room ports, for passing out a hawser.

Cat-hook. (*Nautical.*) A large hook on the cat-block, for attaching to the ring of the anchor in *catting*.

Ca-top'ter. A reflecting optical instrument.

Ca-top'tric Cis'tu-la. A box with several sides, lined with looking-glasses, so as to multiply images of any object placed in the box.

Ca-top'tric Di'al. A dial which shows the hour by means of a piece of looking-glass, adjusted to reflect the solar rays upward to the ceiling of a room on which the hour-lines are delineated. A *reflecting-dial*.

Ca-top'tric Light. A mirror, or series of concave mirrors, preferably parabolic, by which the rays from one or more lamps are reflected in a parallel beam, so as to render the light visible at a great distance.

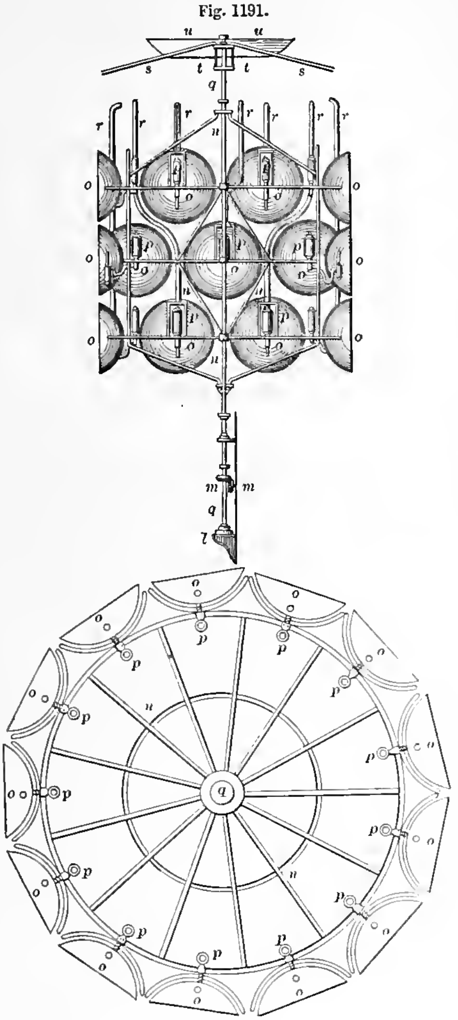
This was the arrangement universally employed in lighthouses previous to the invention of the Fresnel lens. See DIOPTRIC LIGHT; LIGHTHOUSE.

Catoptric lights are susceptible of nine separate distinctions, which are called *fixed*, *revolving white*, *revolving red and white*, *revolving red with two whites*, *revolving white with two reds*, *flashing*, *intermittent*, *double fixed lights*, and *double revolving white lights*.

The illustration shows a revolving apparatus on the *catoptric* principle. The upper figure is a side elevation; the lower figure a horizontal section.

n n shows the reflector-frame or chandelier ; *o o* the reflectors with their oil-fountains *p p*. The whole is attached to the revolving axis or shaft *q*. The copper tubes *r r* convey the smoke from the lamps ; *s s* are cross-bars which support the shaft at *t t ; u u* is a copper pan, for receiving any moisture which may accidentally enter at the central ventilator in the roof of the light-room ; *l* is a cast-iron bracket, supporting the cup in which the pivot of

Fig. 1191.



Catoptric Light.

the shaft turns ; *m m* are beveled wheels, which convey motion from the machine to the shaft. The machinery does not reqnire any particular notice, being that of common clock-work, moved by the descent of a weight.

The horizontal sectional view shows a plan of one tier of reflectors arranged in the manner employed in a fixed catoptric light ; *n n* shows the chandelier, *q* the fixed shaft in the center which supports the whole, *o o* the reflectors, and *p p* the fountains of their lamps. In this figure (in order to prevent confusion) only one tier of reflectors is shown ; the other tiers are so arranged that their axes divide into equal angles the arcs intercepted between the axes of the adjoining reflectors on the first tier, thereby prodncing the nearest approach to an equal distribution of the light which is attainable by this arrangement.

Cat-rake. A name for a *ratchet-drill.*

Cat's'paw. (*Nautical.*) A hitch in a rope for the attachment of a tackle.

Cat-ship. A ship on the Norwegian model, having a narrow stern, projecting quarters, and a deep waist.

Cat-tack'le. (*Nautical.*) A tackle to raise the anchor to the cat-head.

Cat'tle-feed'er. An arrangement in a cattle-stable for snpplying the feed in regulated quantities to the rack or manger.

Cat'tle-guard. (*Railway Engineering.*) A ditch alongside a public road, and crossing beneath the railroad way, to prevent the straying of cattle on to the track.

Cat'tle-lead'er. A nose-ring or gripper for the septum of the nose, whereby dangerous cattle may be fastened or led.

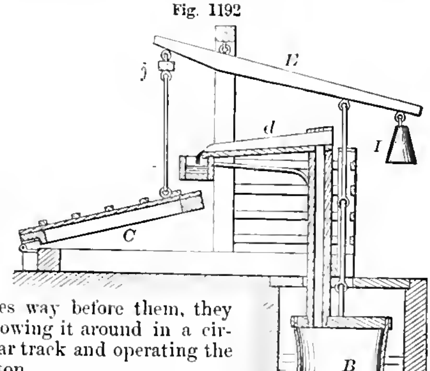
Cat'tle-mark'ing Shears. A kind of scissors adapted for making marks on cattle by cutting off the hairs in such lines as to form letters or figures constituting initials or private marks of the proprietors.

Also, scissors adapted for cutting slits or notches in the ears of cattle, sheep, or hogs, as a means of identification, familiarly known as *ear-marks.* The shears has sometimes a punch attached for making holes in the ears, for the same purpose. Time was when they marked men so.

In all pasturing countries some means are necessary for the identification of cattle running at large. On the tombs of ancient Egypt we see the cattle being branded. This is yet the practice in Texas, South America, and elsewhere. The swans in the Thames are marked by nicks on their bills. Sir John Perrot (in 1584) ordered the Irish to mark all their cattle with pitch or ear-marks, on pain of forfeiture.

Cat'tle-pump. A pump which is operated by the cattle coming to drink, either by their weight upon a platform or by pressing against a bar which

Fig. 1192



Cattle-Pump.

gives way before them, they following it around in a circular track and operating the piston.

The illustration is one of the former kind. The weight of the cattle on platform *C* moves the lever *E*, and raises the bottom-board of the pump-chamber *B*, discharging water at the spout *d*. When the animal leaves the platform, the weight *I* helps the descent of the bottom-board, and the water passes upward through valve *u*.

Cat'tle-stall. A means for fastening cattle at their mangers or racks, other than by halter or tie. It usually consists of a pair of parallel vertical stanchions, at such distance apart as to admit the neck of the animal. One stanchion is movable, to allow the head of the animal to pass, and is then replaced and held by a latch or pin.

The improvements in cattle-stalls refer to the floors, divisions, mangers, racks, troughs, feeding devices, ties; also to devices to prevent crib-biting, for slinging sick or refractory animals, preventing kicking.

The feeders are made in various ways: Opening automatically at regulated periods; closing, to prevent access in the intervals of feeding; arrangements for deposition in the manger of regulated quantities of feed at certain times.

Cat'tle-tie. A fastening for securing cattle at the rack or manger. The varieties are numerous. Some refer to means for releasing all the animals simultaneously in case of fire.

Different kinds of fastenings for the rope, halter, or collar-strap, by which the animal is secured; such are loops, snap-hooks, euphroes.

Means for taking up the slack of the halter-rope, to prevent the animal becoming tangled in it and being thrown; such are falling weights and springs.

Means for fastening the hitching end of the rope to the manger, stall, post, or stanchion; such are hooks, rings, clamping-cams, latches, etc.

Other similar devices may be found under HITCHING; HALTER; TETHER.

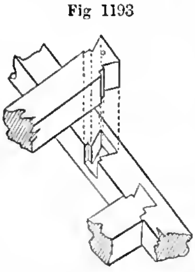
Cat'ty. The bill-hook or machete of Ceylon.

Cauf. 1. A chest with holes to keep fish alive in the water.

2. A large basket, used for raising coals from the bottom of a mine. A *corve.*

Cauk'ing. (*Joinery.*) A dovetail, tenon, and mortise-joint by which cross-timbers are secured together. It is used for fitting down tie-beams or other timbers upon wall-plates.

Fig 1193



Cauking.

Caul. A heated board used in laying down large veneers. Its heat keeps up the fluidity of the glue until all that is superfluous has been pressed out at the edges.

Caunt'er-lode. (*Mining.*) A lode which inclines at a considerable angle to the other contiguous veins.

Cause'way. (*Civil Engineering.*) A road across a marsh or water, supported by an embankment or by a retaining wall. In contradistinction to a viaduct, which is supported by trestle-work, or by arches or trusses resting on piers. See EMBANKMENT.

Caus'son. A nose-band or *twitch* for breaking horses. See CAVESSON; BARNACLES.

Cau'ter. A searing-iron.

Burning with a red-hot iron was practiced by the Libyans, in the time of Herodotus (450 B. C.), as a cure for salt-rheum. The practice is still in vogue there. Cautery, we learn from Denham, is "the sovereign Arab remedy for almost every disorder." We read of it in Hippocrates. Layard noticed the use in Mesopotamia; Burton among the Egyptians.

The *cautery* was a favorite surgical instrument with ancient chirurgeons. One of iron, shaped like a spade, was found by Dr. Savenko, of St. Petersburg, 1819, in the house of a Roman surgeon in the Via Consularis, Pompeii.

The cauter is used by farriers in veterinary operations.

Cau'thee. (*Fabric.*) A coarse East India cotton cloth.

Cau'ting-i'ron. A searing-iron. See CAUTER.

Cav'a-lier'. (*Fortification.*) An elevated work on the terreplein of a *bastion* serving to command the work or some other position, and also serving as a *traverse* to protect the neighboring curtains from enfilade fire.

Cav'a-lot'. A cannon carrying a ball of 1 pound.

Cave. The ash-pit of a glass furnace.

Cav'es-son. A nose-band for breaking-in horses. Otherwise spelt *causson, cavezon.* It resembles the *twitch* or *barnacles*, being a grip by which the nose is wrung and twisted, to subdue the refractory spirit of the animal.

Ca-vet'to. (*Architecture.*) A form of hollow molding whose profile is the quadrant of a circle. See MOLDING; SCOTIA.

A *rampant* cavetto is perpendicular.

Cav'il. 1. (*Nautical.*) A large cleat. See KEVEL.

2. A small stone axe with a flat face and a pointed peen. Resembles a *jedding*-axe.

Cav'in. (*Fortification.*) A hollow way from a protected approach to a defended work.

Cav'ing-rake. A rake for separating the chaff (Eng. *cavings*) from grain, when spread on the barn-floor.

Cax'on. (*Metallurgy.*) A chest of ores, calcined, ground, and washed, ready for the refining-furnace. From the Spanish *caxon, cajon,* a large chest.

Ca'zo. (*Metallurgy.*) A vessel with a copper bottom in which ores of silver are treated in the *hot process.*

Cec'o-graph. The French writing-apparatus for the blind. A *chiragon.*

Ceil'ing. 1. (*Architecture.*) The upper surface of a room.

Plane ceilings are flat.

Domed, cylindric, or *groined* are terms which explain themselves.

Coved ceiling has a hollow of about a quarter-circle running round the room, situated above the cornice and dying into the flat central portion.

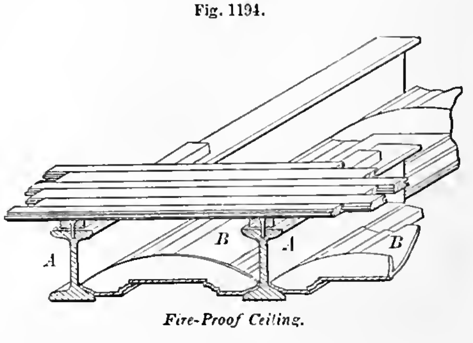
Coffer-work ceiling is arched, and has ornamental panels separated by belts.

Gothic ceilings have groined work with spandrel framing and paneling; the framing of the roof is exposed.

Sunk-panel ceiling has recessed compartments, with roses in the middle and bolection-moldings around them.

Camp ceiling has the marginal portion slanting, following the slope of the rafters, while the middle portion is flat.

Fig. 1194.



Fire-Proof Ceiling.

Fire-proof ceilings are of incombustible materials *B* supported on iron joists *A*, as in Fig. 1194.

2. (*Shipbuilding.*) That portion of the inside skin of a vessel between the deck-beams and the *limber-strakes* on each side of the *keelson*. Also called the *foot-waling*. The strakes of the *ceiling* immediately below the *shelf-pieces* which support the deck-beams are called *clamps*. The outside planking is distinctively called the *skin*.

Ceil'ing-joist. (*Building.*) One of the *joists* spiked to a *binder*, and serving as a point of attachment for the plastering laths of the ceiling.

Cel'a-ture. The art of engraving, chasing, or embossing metals.

Cell. 1. (*Architecture.*) *a.* The space between two ribs of a vault.

b. The space inclosed within the walls of an ancient temple.

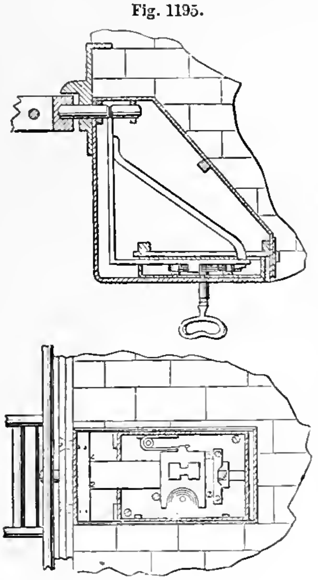
2. (*Electricity.*) A single jar, bath, or division of a compound vessel, containing a couple of plates, — say copper and zinc, — united to their opposites or to each other, usually by a wire. See GALVANIC BATTERY.

3. An underground room for storage.

4. A small room for a prisoner.

5. A structure in a wrought-iron beam or girder; a tube consisting of four wrought-iron plates riveted to angle-iron at the corners. See ANGLE-IRON.

Fig. 1195.



Cell-Door Lock.

Cell-door Lock. A prison-door lock, to whose bolt no access is possible from the inside, and which may fit, as in the example, in a rabbet in the door-jamb.

The secondary bolt is supported in the inclosing shell by brackets, and is connected to the main working parts of the lock by brace-bars, so that the key gives it a movement parallel with that of the common bolt. The inclosing case has a hinged, right-angled cover, the inner fastening of which is covered by the door when closed.

Celt. The stone hammer or axe of a bygone age. Afterwards made of bronze. See HAMMER; HATCHET.

Ce-ment'. 1. A uniting composition which is plastic when applied, but hardens in place. The ingredients and character vary with the place, purpose, materials to be united, and the exposure.

ALABASTER. *a.* Plaster-of-paris, 1; yellow resin, 2; mix and apply hot, warming the faces of the fracture or joint.

b. Sulphur or shellac, melted with plaster-of-paris. Simple plaster-of-paris.

ARCHITECTURAL. Paper pulp, sifted whiting, and size. This is a sort of papier-maché, and must be varnished or painted if exposed to the weather.

ARMENIAN. See JEWELER'S, *d.*

BOTTLE. Rosin, 4; tallow or suet, 1; melt together and stir in the required coloring-matter, — whiting, ochre, or ivory-black. Use hot.

CHEMICAL. See GLASS.

CHINESE. *a.* Shellac, 1; alcohol, 2; digest in a corked bottle in warm water.

b. Borax, 1; water, 12; shellac, 3; evaporate to the required consistence.

COPPER. (To lay upon the rivets and lapping edges of copper-sheets.) Powdered quicklime, bullock's blood.

CUTLER'S. (For fixing knives in handles.) Black rosin, 4; beeswax, 1; brick-dust, 1.

DEXTRINE. Torrefied starch.

DIAMOND. See JEWELER'S, *d.*

EARTHENWARE. *a.* (Coarse.) Yellow rosin and brick-dust melted together.

b. (Finer; for certain purposes.) Brimstone.

c. Grated cheese, 2; quicklime, 1; white of egg sufficient to form a paste.

d. White of egg and quicklime.

e. Dried and ground milk-curds triturated with ten per cent of powdered quicklime. Keep from the air, mix with water for use, and apply immediately.

ELASTIC. Caoutchouc dissolved in chloroform, with or without powdered gum-mastic.

ELECTRIC APPARATUS. Beeswax, 1 lb.; rosin, 5 lbs.; red ochre, 1 lb.; plaster-of-paris, 2 oz.

FIRE-PROOF. Fine river-sand, 20; litharge, 2; quicklime, 1; linseed-oil to form a paste. Applied to walls, it becomes stony-hard.

GAS-FITTING. Rosin and brick-dust.

GLASS. *a.* Dissolve gum-mastic, 1 ounce, in alcohol; soak 1 ounce of isinglass in water; add alcohol to dissolve it to a strong glue, and add ½ ounce of sal-ammoniac. Put the two solutions into a pipkin; heat, and stir. Put in a stoppered vial, and warm in a water-bath when about to use it.

b. (For chemical glasses.) Flour, 1 ounce; pulv. glass, 1 ounce; pulv. chalk, 1 ounce; fine brick-dust, ½ ounce; scraped lint; white of egg. Spread on a linen cloth, and apply to the crack of the glass.

c. (For a temporary stopping or lute.) Yellow wax, 4; turpentine, 2; Venetian-red, 1.

d. White of egg and quicklime. It does not long resist moisture unless exposed to the heat.

e. (For lens-grinders, etc.) Melt together, pitch, 5; wood-ashes, 1; hard tallow, 1.

Or, Black rosin, 4; beeswax, 1; heated whiting, 16.

Or, Shellac, melted.

Or, Rosin and plaster-of-paris.

f. To unite lenses, Canada balsam.

g. (To attach metallic letters to plate-glass windows.) Copal varnish, 16; drying-oil, 6; turpentine (Venice), 3; oil of turpentine, 3; liquified glue, 5; melt, and add quicklime, in powder, 10.

h. (For necks of bottles.) Linseed-meal in boiled oil. Paraffine.

GLUE. *a.* A strong glue, sold as a cement, may be made by infusing glue and isinglass in alcohol, heat gently, and add powdered chalk.

b. *Ure's* glue (dissolved), 8; linseed-oil, boiled to varnish with litharge, 4.

c. Dissolved glue, 4; Venice turpentine, 1.

d. (Waterproof.) Dissolve isinglass, 2 ounces, in a pint of milk, and boil to a consistence.

e. Glue swelled in cold water and digested in linseed-oil is tenacious, and acquires the quality of resisting moisture. Red lead may be added.

f. *Marine glue*; shellac and caoutchouc dissolved in separate portions of naphtha, and mixed.

g. *Spalding's* liquid glue; glue and acetic acid.

GRANITE. Gum-dammar, marble-dust, felspar. The mineral ingredients are reduced to an impalpable powder, and the mass is incorporated by gradual heating. It is applied warm to the warmed faces of the fractured portions. The black felspar is preferably used, to prevent the detection of the joint.

HARD. *a.* Dried and pulverized clay, 8; clean iron-filings, 4; peroxyde of manganese, 2; sea-salt, 1; borax, 1. Triturate, reduce to paste with water, use immediately; heat after using.

b. Peroxyde manganese, zinc-white, silicate of soda, to form a paste.

HYDRAULIC. *a.* The ancient hydraulic cement is the pozzuolana, a volcanic earth obtained near Baiæ, in Italy. See POZZUOLANA.

b. Hydraulic mortar or cement is made from argillaceous limestones, the presence of the alumina conferring the power of hardening under water. Hydraulic limes were known to and understood by the Romans. Attention was directed to the subject by Smeaton, when he experimented for a cement capable of hardening under water, in order to form his foundation courses for the Eddystone lighthouse.

c. The French cement made at Meudon, near Paris, is made of chalk 4 parts, clay 1 part, ground in water, settled, molded, dried, and calcined.

d. The Portland cement of England is made of chalk and clay from the valley of the Medway. The septaria and lias rocks also yield an hydraulic cement.

Artificial pozzuolana is also made from lime and clay.

e. Gad's patent (English); dried clay in powder, 3; oxide of iron, 1. Make into a paste with boiled oil. Will harden under water.

f. Mix clay, broken pottery, flint and bottle glass, into a frit; grind, sift, and mix with one third its weight of quicklime; keep from the air. In using, mix into a mortar, and apply like pozzuolana.

IRON. *a.* (For steam-boilers, cracked ovens, etc.) Litharge, 2; fine sand, 1; slaked lime, 1. Mix, and keep dry.

b. Iron-borings, powdered earthenware, pipe-clay, salt, water.

c. Steam and water tight joints, in permanent cast-iron works, are made by an iron cement compounded as follows: Cast-iron filings or borings, 112; sal-ammoniac, 1; sulphur, 1, whitening, 4.

Small quantities are mixed with a little water just before using.

For minute cracks the cement is laid on externally as a thin seam. For larger fissures it is driven in with a calking-iron. The edges of the metal and the cement are involved in one common mass of rust, which is impermeable to steam or water.

d. Clean iron-filings, 16; sal-ammoniac, 3; flour of sulphur, 2. Mix, and keep stoppered.

In use, take 1 part of the mixture, 12 parts of new filings, add a few drops of sulphuric acid, and fill the crack or the joint which requires it.

e. Mix boiled linseed-oil, litharge, red and white lead. Apply on each side of a piece of flannel or paper, and lay the same between two pieces before they are bolted together.

f. (For fire-joints and flues.) Iron-filings, sal-ammoniac, and borax.

JEWELERS'. (For uniting the pieces of a broken gem.) *a.* Warm the parts, and place gum-mastic between them. It will melt by the heat, and will be scarcely observable.

b. (For temporarily holding a glass, set, or a piece of metal, while being shaped or chased.) Rosin, 4; wax, ¼; whiting, 4. Mix and heat.

c. Take pitch, rosin, a small quantity of tallow, and thicken with brick-dust. Stir in a pipkin over a fire.

d. (Armenian cement for uniting metals.) Dissolve gum-mastic in alcohol and isinglass (previously softened in water) in brandy, adding a little gum-galbanum, or gum-ammoniac, previously rubbed fine. Mix under heat; keep in stoppered vial, which is placed in hot water when the cement is to be used. This is *diamond cement.*

The Armenian artificers set the jewel in a metallic setting whose lower surface corresponds to the shape of the article on which it is to be placed. The two are then united by the cement.

LEATHER. (For leather and cloth.) *a.* Gutta-percha, 3; caoutchouc, 1; digested in bi-sulphuret of carbon, 8.

b. Gutta-percha, 16; caoutchouc, 4; pitch, 2; shellac, 1; linseed-oil, 2.

MARBLE. Plaster-of-paris steeped in a saturated solution of alum and re-calcined. Mix with water, and apply as plaster-of-paris. This cement or stucco is susceptible of a high polish, and may be colored to imitate marbles.

See also STONE; GRANITE; *infra.*

MASTIC (Bottger's). Sand, limestone in powder, litharge, combined, 100 parts; boiled linseed-oil, 7 parts. Mix. Similar to Loriat's French mastic, invented 1750.

MORTAR. *a.* Sharp, clean sand, 3; freshly slacked lime, 1. See BETON; STONE, ARTIFICIAL; MORTAR.

b. *Parker's cement,* known as *Roman,* patented in England in 1796, is made by adding a quantity of calcined and powdered argillaceous stone to the usual constituents of mortar, namely, sharp sand, lime, and water.

Cements from sulphate of lime: —

c. *Keene's cement* is made from plaster-of-paris mixed with a saturated solution of alum, dried, baked, powdered, and sifted.

d. *Parian cement,* same as above, with the substitution of borax for alum.

e. *Martin's cement,* same as above, with the addition of pearl-ash to the alum.

f. *Stucco* is a combination of plaster-of-paris with gelatine solution.

g. *Scagliola* is made of plaster-of-paris powdered, mixed into a paste with alum, isinglass, and coloring matter, and is incorporated with fragments of marble.

OPTICIANS'. See GLASS.

PAPER. *a.* Rice digested in water, applied hot.

b. Flour paste. A little powdered alum is said to improve its quality, and a little corrosive-sublimate or creosote to prevent its becoming moldy.

c. Mucilage of gum-arabic, thickened with starch. Used by French makers of artificial flowers and ornamental boxes. Also by naturalists in mounting specimens.

d. Sealing-wax.

e. (For postage stamps.) Dextrine and size.

PHOTOGRAPHER'S. Dextrine, paste, and glue.

PLUMBERS'. Rosin and brick-dust melted together.

ROMAN. See MORTAR, *b; supra.*

SEAL-ENGRAVERS'. Rosin and brick-dust. Melted together, and used to temporarily fasten an object to a chuck while engraving or chasing.

SLATE. (For the joints of slate-work on roofs or in tanks.) Boiled linseed-oil, white lead, chalk, intimately compounded, and used in a fluid condition.

STONE. Fine sand, 20; litharge, 2; quick-lime, 1; linseed-oil to form a paste.

See also cements, alabaster, glass, earthen, granite, diamond, Armenian, Chinese, etc., *supra.*

STOVE. (For cracks in stoves and other iron-ware.) Finely pulverized binoxide of manganese, mixed with a strong solution of silicate of soda, to form a thick paste. Fill the crack, and heat slowly.

Another: Dry clay, 4; borax, in solution, 1.

TURNER'S. (For chucking articles.) Rosin and brick-dust, melted together.

WATERPROOF. *a.* (For covering of bungs, etc.) India-rubber (digested), beeswax, tallow, and quicklime.

b. (For joining rubber goods.) Caoutchouc in naphtha or turpentine.

WOOD. 1. *a.* (For attaching a piece of wood to a chuck for turning, and for other purposes.) Rosin, 1 pound; pitch, 4 ounces; brick-dust or red ochre, to give consistence; add tallow in winter.

b. Shellac, 1; alcohol, 2. Digest in a corked bottle, in warm water.

2. (*Mining.*) The gravel cemented by clay, which lies next to the bed-rock of the ancient stream, but is now buried beneath a mass of lava and gravel-drift, sometimes many hundreds of feet in depth. This auriferous stratum is reached by timbering, draining, and hoisting, as in other underground operations, or the overlying deposits by *hydraulic mining*, which consists in washing away the superincumbent mass. This system is principally practiced in Sierra Nevada and Placer Counties, California. The *cement* of these "deep placers" is crushed by stamps, and the free gold collected by sluices or other means. See Professor Raymond's "Mines, Mills, and Furnaces."

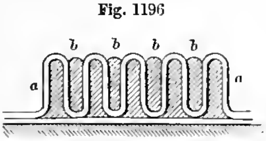
3. (*Metallurgy.*) *a.* The brown deposit in the precipitation tank, wherein the soluble chloride of gold, obtained by the *chlorination* process, is deposited by the addition of sulphate of iron to the solution.

b. The material in which the metal is imbedded in the CEMENTING-FURNACE (which see).

Cem'en-ta'tion. (*Metallurgy.*) The process of infusing a solid body with the constituents of another body in which it is buried, by the application of heat; as the conversion of iron into steel by adding to it a certain proportion of carbon. See CEMENTING-FURNACE.

Ce-ment'ed-back Car'pet. In forming cemented-back carpet a number of warp-threads *a a* are arranged in a frame, and are brought into a convoluted form by means of metallic plates *b b*, which are laid strictly parallel. The under side of the warps thus doubled or folded are then dressed to raise a nap, and this surface is then smeared with cement and backed by a canvas or coarse cloth. When dry, the metallic strips *b b* are removed by cutting the loops, and leaving a pile surface, as in the *Wilton* carpets.

Fig. 1196



Cemented-Back Carpet.

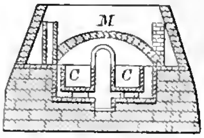
Another mode is to wind the colored yarns around wires, which are then laid parallel; one surface treated with cement and backed with canvas; the other cut like a Wilton carpet when the backing is dry.

Another mode is to fill a square box with parallel yarns laid according to a design, so that a transverse section across the yarn will show the pattern. The ends of the box being open, a piston is introduced at one to expel the yarns at the other. At the discharge-end, the surface, being cut fair, is cemented, and a cloth applied to it. A quantity of the yarn, equal to the length of the pile, is then cut off, and adheres to the backing. The surface is again cemented, the yarn protruded, the backing applied, the pile cut off, and so on.

Ce-ment'ing-fur'nace. A furnace in which an article is packed in the powder of another substance, and therewith subjected to a continued heat below the fusing-point. The article is changed by a chemical reaction with the powder.

Bar-iron, packed in charcoal and heated in a cementing-furnace, becomes steel, the iron absorbing some of the carbon.

Fig. 1197.



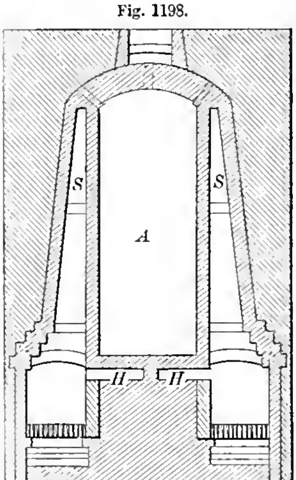
Cementing-Furnace.

Cast-iron, packed in powdered hematite and similarly heated, becomes malleable; the oxygen of the hematite absorbing some of the carbon of the iron.

The troughs *C* are so supported beneath the arch *M* of the furnace, that the fire has free access to their whole exterior surfaces. The bar-iron is imbedded in charcoal in the troughs *C*, being arranged in tiers with interposed layers of charcoal, no two bars being in contact. The tops of the troughs are covered in with fire-tiles, or the upper layer with refractory sand, and the heat is increased for several days, and then maintained for a period depending upon the kind of steel required. The finer varieties of steel are produced by a prolonged process, and the bars are sometimes exposed again and again to the process of cementation.

In Fig. 1198 is an oven for converting iron into steel. The converting-chamber *A* is surrounded at bottom and on the sides by the fire-spaces *H S*. The furnaces and grates extend along each side of the base of the converting-chamber, and from end to end of the oven, leaving an opening at each end for the admission of fuel. A longitudinal line of fire-brick prevents the draft from passing from one furnace to the other. Above the boshes the walls are made to incline inwards, in order to confine the heat more closely to the sides of the converting-chamber. At the top the spaces communicate with the interior of the converting-chamber by means of holes, which are made smaller towards the center of the chamber than at the ends.

Fig. 1198.

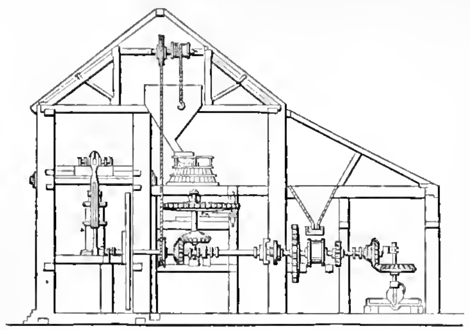


Cementing-Furnace.

Ce-ment'-mill. A mill for grinding the septaria or stony concretions from which cement is derived.

The machinery is driven by a steam-engine, shown to the left in the illustration, and the motion is communicated by a horizontal through-shaft to all the machinery in the mill. The operations exhibited are threefold. The cement-stone is crushed between a pair of rollers on horizontal shafts beneath the hopper to the right hand. Falling to the floor, it is elevated to the upper story and dumped into a hopper, from whence it passes into the eye of the runner mill-stone and is finely pulverized. The stones have a face dressing like those for grinding grain, the oblique channels being laid over in sections. From the mill the powder passes to a pair of sieves, wh ch receive a rapid horizontal reciprocation by a

Fig. 1199.



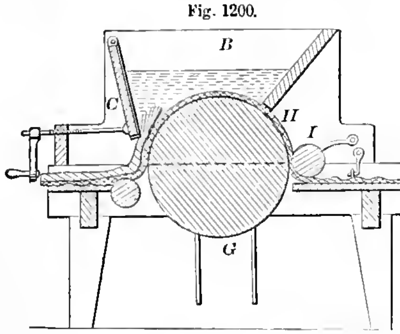
Cement-Mill.

rod and crank attached to the small spur-wheel, which is turned by the large spur-wheel on the spindle beneath the bed-stone.

To the right is shown a mortar-mill, which consists of an edge-wheel traveling in a circular bed, like that of a Chilian ore-mill. This stone has an axle which projects radially from a vertical post which is rotated by spur-gearing from the main horizontal shaft of the mill. A scraper on the stone cleans the face of the edge-stone.

Ce-ment′-spread′er. A machine for coating and saturating felt or paper with liquid cement, for roofing purposes. The cloth or paper *H* passes under

Fig. 1200.



Cement-Spreader.

roller *I* and over the roller *G* into the liquid-cement hopper *B*, and passes out between the roller and the adjustable gate *C*, which gages the quantity of cement which passes out with the cloth.

Cen′drée de Tour′nay. A hydraulic cement of aluminous quicklime and coal-ashes.

The ash s and lime from the bottom of the kiln are sifted, to remove lumps. The dust is slacked a bushel at a time till the mortar-box is filled. The mortar is then well incorporated by a pestle suspended at the end of an elastic pole. It is then partially dried, again beaten, and this is repeated from six to ten times, no more water being added. It adheres very firmly to bricks or stone, and hardens under water.

Cen′ser. A brazier or pan for burning aromatic woods and spices.

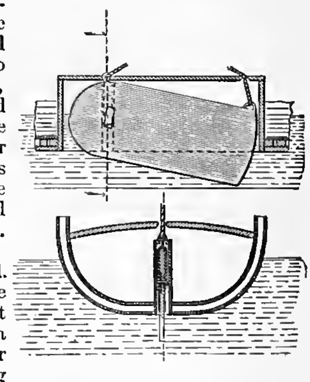
Cen′ter. (*Lathe.*) One of the points on the lathe-spindles on which the work is placed. The *front* or *live center* is on the spindle of the *head-stock*. The *back* or *dead center* is on the *tail-stock*.

The *centers* of a *planer* are on stocks temporarily attached to the bed of the planer, so that the object may be turned on its axis in the course of the work thereon.

Cen′ter-bit. A wood-boring tool which has a central pivot and two wings; one of these is a *scriber* and the other a *router*. See Bit.

Cen′ter-board. (*Nautical.*) A board placed amidship in a well which extends longitudinally and vertically through the keel, and is adapted to be lowered to give a deeper draft, in order to avoid lee-way and to give the vessel greater stability under press of canvas. It is the old Dutch lee-board in a central position. A *sliding-keel*.

Fig. 1201.



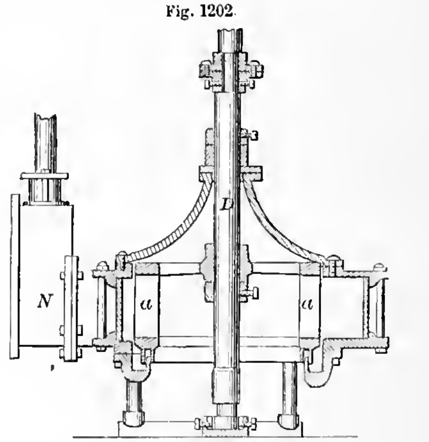
Center-Board.

Cen′ter-chis′el. A chisel used to make a dent at the exact center, to form a starting-point for the drill, in drilling holes in metal. A pointed cold-chisel.

Cen′ter-chuck. (*Turning.*) A chuck which can be screwed on the mandrel of a lathe, and has a hardened steel cone or center fixed in it; also a projecting arm or driver.

Cen′ter Dis-charge′-wheel. A form of turbine, in which the water is admitted from a chute *N*

Fig. 1202.



Center Discharge-Wheel.

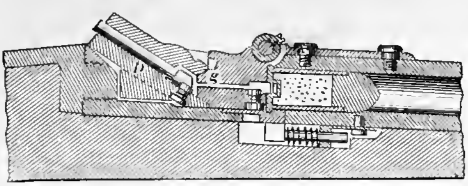
to the periphery of the buckets *a a*, passes towards the center of the wheel, and thence downward around the axis *D*.

Cen′ter-drill. A small drill used for making a short hole in the ends of a shaft about to be turned, for the entrance of the lathe-centers.

Cen′ter-fire Car′tridge. One in which the fulminate occupies an axial position, instead of being around the periphery of the flanged capsule.

In the illustration the fulminate is in a cap, and

Fig. 1203.



Center-Fire Cartridge.

is struck by a firing-pin *g*, when the hammer descends upon the end of the bolt *D*. See CARTRIDGE.

Cen′ter-gage. A gage for showing the angle to which a lathe-center should be turned, and also for accurately grinding and setting screw-cutting tools.

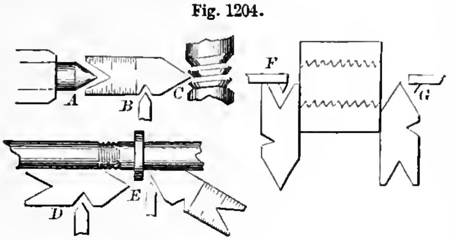
The annexed cut shows the tool, and illustrates its uses.

At *A* is shown the manner of gaging the angle to which a lathe-center should be turned. At *B*, the angle to which a screw-thread cutting-tool should be ground, and at *C*, the correctness of the angle of a screw-thread already cut.

In the lower figure, the shaft with a screw-thread is supposed to be held on the center of a lathe. By applying the gage as shown at *D* or *E*, the thread-tool can be set at right angles to the shaft, and then fastened in place by the screw in the tool-post, thereby avoiding imperfect or leaning threads.

In the right-hand figure, the manner of setting the tool for cutting inside threads is illustrated. The angles used in this gage are sixty degrees. The four divisions upon the gage of 14, 20, 24, and 32 parts

Fig. 1204.



Center-Gages.

to the inch are useful in measuring the number of threads to the inch of taps and screws.

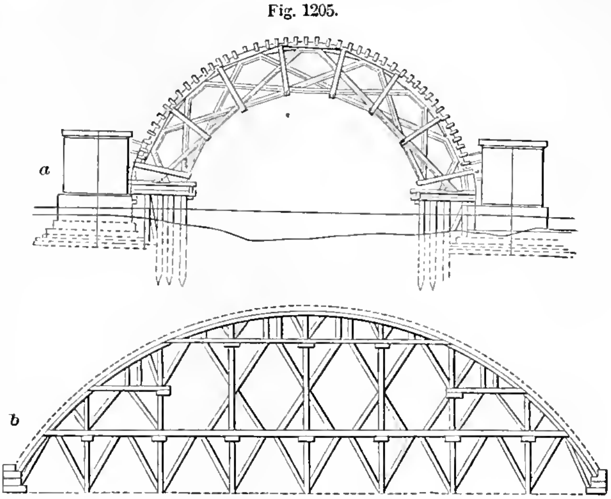
The following parts to the inch can be determined by them: namely, 2, 3, 4, 5, 6, 7, 8, 10, 14, 16, 20, 24, and 32.

Cen′ter-ing. (*Masonry.*) A temporary support, serving at the same time as a guide to the workmen, placed under an arch during the progress of its construction. Its duty is to support the arch until it has been finally closed by the insertion of the key-stone, and is able to maintain itself in position without extraneous help.

The object is to afford the largest possible amount of support to all the parts; to arrange the timbers so that each part shall be equally supported in proportion to its actual pressure, and to economize — or at least such should be the engineer's aim — timber. The centering is, in fact, a pattern, in wood, of the intrados of the finished arch, and is, in large structures, such as first-class stone bridges, an expensive erection of itself, requiring a large amount of scientific knowledge and practical skill to thoroughly fulfill the required conditions.

The essential features of a *centering* are the *ribs* which span the space between the piers; the *bolsters*, or boarding, which lie transversely and support the *voussoirs*; the *keys*, or *striking-plates*, beneath the ribs, which are struck to lower the centering; and

Fig. 1205.



Bridge-Centers.

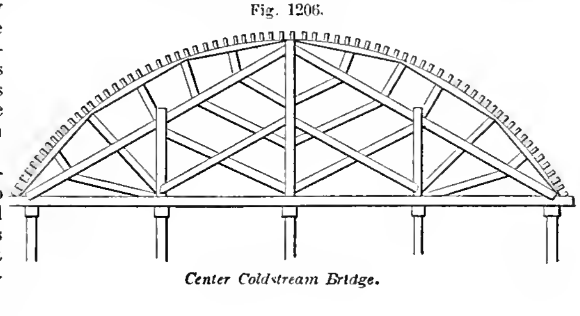
a sufficient amount of framing to hold the *ribs* and *bolsters* securely.

A cocket-centering is one in which head-room is left beneath the arch above the *springing-line*, upon which the temporary supports of the centering may have to rest.

The most elementary form may be seen in the common sewer or culvert, where a simple structure answers the purpose; but in large structures, which may have to support a pressure of many hundreds of tons, careful calculations are required, involving a knowledge of the strength of materials and resolution of thrust. Engineering skill is also necessary in securing proper foundations under the widely varying circumstances of the soil and substrata.

Fig. 1205, *a* is a center used at Westminster Bridge, an improvement on Perronet's system. Two timbers resting on the abutments incline and meet at the top, forming a large triangle; this is crossed and braced in different directions, constituting seven compartments, and affording considerable strength.

Fig. 1206.



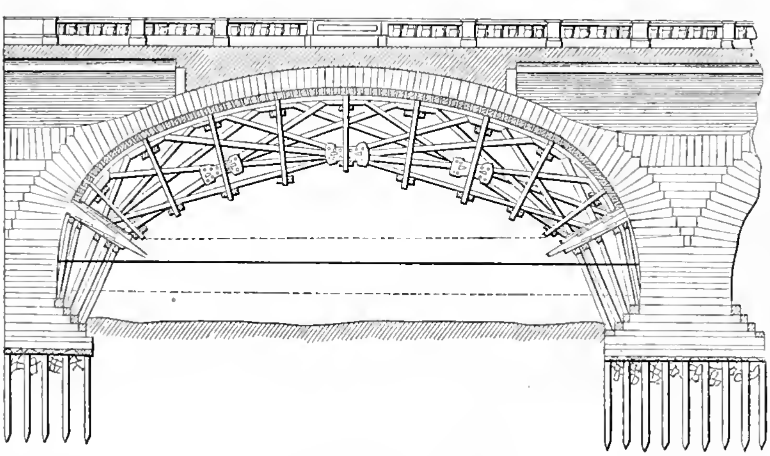
Center Coldstream Bridge.

Centers of 130 feet span have been formed by the arrangement represented in Fig. 1205, *b*, composed of vertical and horizontal timbers with diagonal braces; the upper portion is contrived to rest upon wedges, and can be lowered without disturbing the rest; by striking the inclined supports at bottom, their position can be altered when desired. These centers have the advantage of simplicity, and can be easily put together and taken down.

Smeaton's center for Coldstream Bridge resembled a roof-truss in its general arrangement, consisting of a frame with a tie-beam united by a system of braces; on each side were struts supporting the ribs, on which was laid the planking for turning the arch.

The centers devised by Rennie for the arches of Waterloo Bridge have been often cited as admirably arranged structures of their kind. Inclined "piles," which carried the weight of the ribs of the center, had their bearings on the offsets of the stone piers, which afforded an excellent abutment. The ribs were laid upon whole timbers capping the piles, and under each set of ribs wedges were introduced, which were made to extend across the whole width; when it was required to ease the center, the wedges were driven along each other, and slid down the inclined plane into larger spaces than they had formerly occupied. The whole center could by this means be made to descend very gently, and be retained at any required position during the progress of the work.

Fig. 1207.

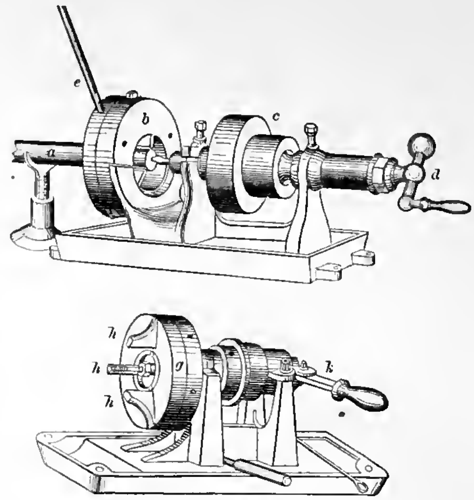


Center Waterloo Bridge.

An elevation of the framing is shown in Fig. 1207. This center is said to have had remarkable strength, and when struck, the arch settled but a very few inches.

Cen′ter-ing-ma-chine′. A form of machine-drill for centering shafts, bolts, etc. The purposes are various, but especially to make such a depression at the exact center that the object may be placed in a lathe for turning. Two illustrations are shown. In the upper one the end of the shaft *a* rests in the crutch, and is held between the three sliding-dogs of the chuck *b*, so that the exact center of end-face is presented to the drill, which is rotated by a band on pulley *c*, and advanced to its work by the tail-screw *d*. The lever *e* is the means of rotating that portion of the chuck which carries the rack or snail by which the dogs are radially adjusted, so as to grasp or release the shaft.

Fig. 1208.

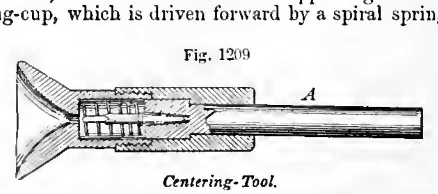


Centering-Machine.

The lower figure has the dogs *h* on the face of the chuck *g*, and these are made to embrace the shaft, bolt, or rod near the end, so as to hold it for the advance of the drill, which, in this case, is moved to its work by the lever-handle *k*, but rotated by the band on the pulley.

Cen′ter-ing-tool. One having a trumpet mouth, into which the end of a shaft may be pushed while the tool occupying the axis may be driven forward, to drill or punch a hole in the exact axial center of the rod. The shaft *A* is attached to the lathe-spindle, and around it is a sleeve supporting a centering-cup, which is driven forward by a spiral spring.

Fig. 1209



Centering-Tool.

Cen′ter-line. (*Shipbuilding.*) A central, longitudinal, vertical section of the hull.

Cen′ter-lathe. 1. A lathe in which the work is supported upon centers at each end; one on the end of the mandrel in the head-stock, and the other, the back-center, on the axis in the tail-stock. The latter is adjustable.

2. A lathe in which the work is held by centers projecting from two posts, and is driven by a band

which passes two or three times around it. The band is fastened at its respective ends to a treadle beneath the lathe and a spring-bar above it. A *pole-lathe.*

Cen'ter-pin. The pivot on which the compass-needle oscillates. See MARINER'S COMPASS; DIP-COMPASS.

Cen'ter-punch. A punch for making an indentation, as a mark for the center of a hole to be drilled, a circle to be struck, or as a center of revolution in the lathe.

Cen'ter-rail. (*Railway Engineering.*) A third, or middle, rail placed between the ordinary rails of a track, and used on inclined planes in connection with wheels on the locomotive in ascending or descending the grade.

The first of these was BLENKINSOP'S patent of 1811. The middle rail was a rack, and was engaged by a cogged wheel on the locomotive by which the ascent was secured.

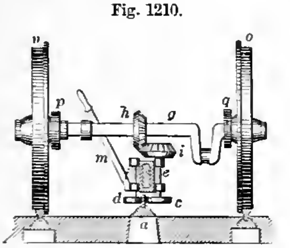
No particular provision was made for descent. The device was primarily intended as an aid to traction, as it was supposed at that time the bite of the drivers on the rail would be insufficient.

SNOWDEN (English), in 1824, had a center-rack and what he called a *mechanical horse.* A bevel cog-wheel on the locomotive acted upon gearing on the *horse*, and the latter had a wheel engaging the center-rack, so the *horse* was advanced and drew the train.

EASTON (English patent, 1825) specifies a central rack placed between the two rails, and a spur gear on the locomotive. In addition to this, the smooth sides of the rail form guides, lateral wheels running in a horizontal plane beneath the engine or carriage, bearing upon the sides of the rail and preventing the swerving of the vehicle from the line or rails. No positive motion was imparted by the engine to the said guide-wheels.

KOLLMAN'S English patent of 1836 has a central guide-rail.

Fig. 1210.



Vignoles and Ericsson's Central Rail.

A central *friction-rail* was patented by VIGNOLES and ERICSSON in England, 1830.

This friction-rail consists of a flat piece of iron fixed in a vertical position in chairs *a*, occupying a median position between the tracks. On each side of the friction-rail is a horizontal friction-roller, as shown at *c d*; the roller *c* being made considerably longer than *d*, and fixed upon its vertical shaft *e*, while *d* is permitted to turn freely on its vertical shaft *f*. On the driving-axis *g* is fitted a bevel-wheel *h*, which turns another bevel-wheel *i*, fixed upon the vertical shaft *c* of the driving-roller *c*. The bearings of this driving-roller and its shaft are firmly fixed to the under side of the locomotive-carriage by a block to which the bearings of the friction-roller *d* are hinged, that the latter may at pleasure be pressed against the friction-rail *a* by the lever *m*. This lever is brought within reach of the engineer. The driving-wheels *n o* may be released from the power of the engine by disengaging the clutches *p q*, so as to throw the whole force of the engine upon the gripping rollers *c d* when ascending a grade.

KOLLMAN'S Locomotive Guide, English patent, 1836, had a pair of rollers acting upon the sides of a center-rail whose upper flanges prevented the rising of the guide-rollers to such an extent as to become disengaged.

SELLERS'S United States patent, 1835, embraced a central rail, clamped between two horizontally rotating rollers driven by the power of the locomotive.

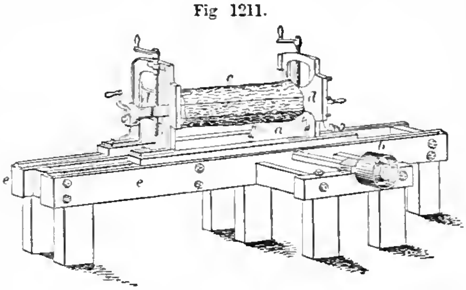
A device similar to that described in Vignoles and Ericsson's English patent, 1830, was adopted by FELL in the Mount Washington Railway, whose steep gradients could not be ascended by the ordinary means.

Mr. Fell adopted the same means in ascending the inclined planes on Mont Cenis.

Another form of center-rail railway has but a single rail in the middle of the track, and a pair of smooth tramways, one on each side, traversed by ordinary wheels.

Cen'ter-saw. A machine for splitting round timber into bolts, instead of riving it, for axe and pick handles, heavy spokes, etc. It has a sliding carriage, furnished with center head-blocks, upon which the log is placed; and is provided with a dial-plate and stops, by which the log can be spaced into stuff the desired size. The centers can be adjusted up or down, to suit the work. Is capable of splitting timber up to 20 inches in diameter, 3½ feet long; cuts invariably toward the center, and is calculated for a saw 22 inches or less in diameter.

Fig 1211.



Center Sawing-Machine.

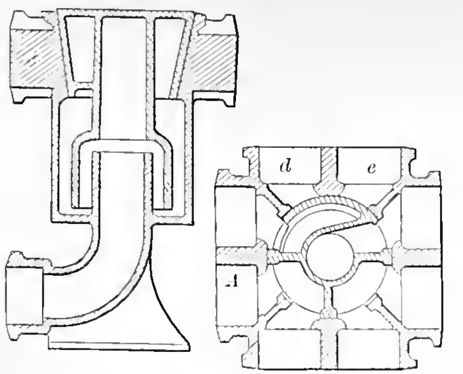
Cen'ter-sec'ond. A term applied to a watch or clock in which the *second*-hand is mounted on the central arbor and completes its revolution in one minute. It is more easily read than the ordinary second-hand traversing in its own small dial.

The beat of the *second-hand* may be seconds, or fractions of a second. In the original form it beat with the balance, a third of a second at a beat.

The largest center-second clock known to the writer is the turret-clock for the Bombay Harbor Board, which indicates hours, minutes, and seconds upon a dial 8½ feet in diameter. The center-second hand measures 6½ feet in length, and its end has a motion of 5 inches per second, acquiring a momentum which has been overcome by a series of sixty levers, so arranged that the second-hand rests in one of them at each beat; the point of the hand being so contrived that when it rests upon a lever it is detained there, and can get neither backwards nor forwards until the clock-work removes the lever out of the way. This prevents the swaying back and forth of the hand, and gives it a dead motion.

Cen'ter-valve. A device in gas-works whose duty is to distribute the coal-gas to the purifiers. In the example annexed, the seat of the valves is a casting *A*, having four pairs of mouths *d e*. The valve itself has a port which may, by rotation, be made to connect with and distribute the coal-gas to any one of the four sets of purifiers.

Fig. 1212.



Center-Valve.

Cen'ter-wheel. The "third wheel" of a watch, in some kinds of movements.

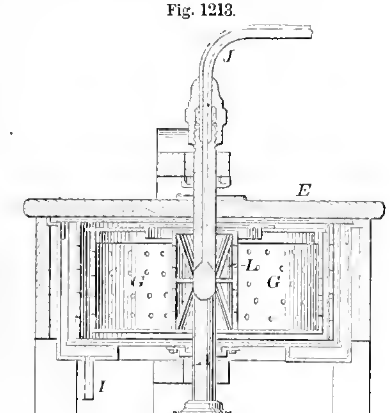
Cen'ti-grade Ther-mom'e-ter. The thermometer of Celsius. The zero is at the freezing-point of water, and the boiling-point is at 100°. See THERMOMETER.

Cen-trif'u-gal Drill. A drill having a fly-wheel upon the stock, to maintain and steady the motion against the effect of temporary impediments. In some cases there is a click movement, so that the fly-wheel may constantly maintain the same direction of motion, notwithstanding the vibratory character of the primary motion.

Cen-trif'u-gal Fil'ter. The centrifugal sugar-filter was patented in the United States by Hurd in 1844, and in England by Finzel in 1849.

Its cylinder has a porous or foraminous periphery, and is very rapidly rotated on its ver-

Fig. 1213.



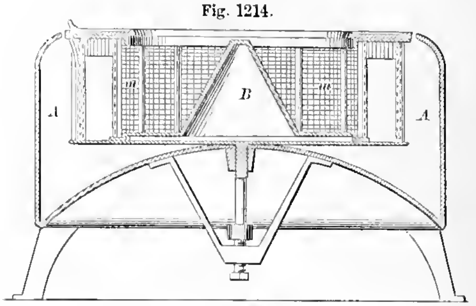
Centrifugal Filter.

tical axis, so as to drive off by centrifugal force the liquid with which the substance contained in the cylinder is saturated. In the illustration annexed, the syrup is introduced by pipe *J* into the distributor *E*, which disperses it to all parts of the chamber *G*, which is filled with bone-black and is rotated rapidly on its shaft *A* by a bevel-pinion driven by the bevel-wheel *B*. *C* is the wheel of the tram-lever, on which the shaft is stepped. The liquid driven out of the cylinder *G* is collected in the envelope-chamber, and discharged by the pipe *I*. Sugar is freed of molasses in the same kind of machine. See CENTRIFUGAL MACHINE.

Cen-trif'u-gal Gun. A form of machine-cannon in which balls are driven tangentially from a chambered disk rotating at great speed.

Cen-trif'u-gal Ma-chine'. A machine for drying yarn, cloth, clothes, sugar, etc., by centrifugal action. The fiber or other material is placed in a hollow cylinder with a reticulated periphery of wire gauze, and, being rotated at a rate of from 1,000 to 2,000

Fig. 1214.



Centrifugal Machine.

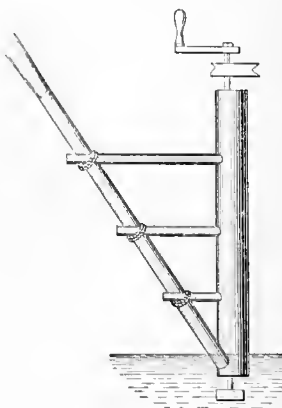
revolutions per minute, the water flies off by the centrifugal action, and is collected by the enclosing cylinder, down which it trickles to a discharge-pipe. It is also found useful in removing the must from the grape after crushing.

The illustration shows a machine with an inner cylinder *m*, and an outer one, both revolving in concert and driving outwardly to the chamber *A* the molasses in the sugar, which surrounds the cone *B*.

Cen-trif'u-gal Pump. A rotary pump in which the fluid is driven outwardly from the center at which it is received, and diverted into an upward direction.

Le Demour's centrifugal pump (Fig. 1215) is supposed to have been the first of its kind. It is but a clumsy contrivance, viewed in the light of the more recent inventions, which are generally forms derived from the turbine.

Fig. 1215.

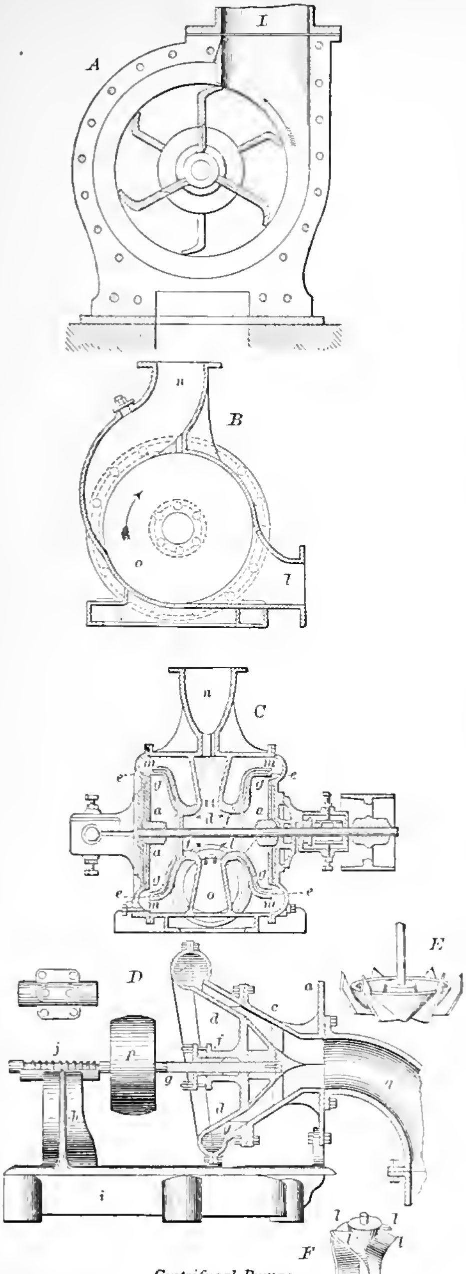


Centrifugal Pump.

They do for water what some forms of fan-blowers do for air, and are also much like many rotary engines in the construction of the parts, only the vanes of the rotary steam-engines are pressed by steam, while those of the centrifugal pump move against the water, and drive *it*. See also ROTARY PUMP.

In the *Konst en Letterbotte*, Haarlem, Holland, April 19, 1841, occurs a suggestion of P. H. Van der Weyde, for the use of a turbine-shaped wheel as a centrifugal pump, the process being inverted so

Fig. 1216.



Centrifugal Pumps.

"that, in place of obtaining power by means of descending water, we may raise water by applying a given power." The centrifugal pump known as the "Gwynne" pump was used by Andrews and Brother in New York in 1844.

In Fig. 1216 are shown several forms of the centrifugal pump, differing more in detail and proportion than in principle.

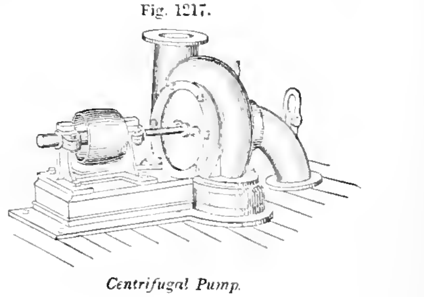
A shows Gwynne's centrifugal pump, which has six equidistant pallets inclined backwardly toward their outer extremities. Three of these extend from the axis, and the remainder only from the margin of the annular induction-space around the axis. The wheel rotates in a shell in the direction of the arrow, and delivers the water upward into the eduction-pipe *L*.

Girard's turbine elevator resembles five distinct turbines on a vertical axis, one above another, each taking the water from the one below it, and delivering it in turn to the one above it.

B C shows the Coignard centrifugal pump, as shown at the French Exposition, 1862. A vertical section across the axis of one of these pumps is shown at *B* (Fig. 1216) and another section, also vertical, through the axis, at *C* (same figure). Here there are two revolving-drums, *g a*, *g a*, both attached to the same axis *d*. They revolve in water-tight boxes, but the entrance of the water takes place from the space *o*, between the drums; the openings for admission being at *f*. The discharge takes place through an annular lateral space *e e e e*, into an annular cavity *m m*, which conducts it to the rising tube *n*. The tube of aspiration is *l*, which communicates with the space between the drums *o*. The form given to the pallets in this machine is spiral; they are only two in number in each drum. As in the other pumps, the form of the helices is professedly such as to make the section of passage inversely proportional to the velocity of the water at different distances from the center.

Andrews's centrifugal pump (*D*, Fig. 1216) resembles a helix or snail's shell, which forms the base of a double cone placed with its axis in a horizontal position, the space between the inner and outer cones being the chamber of the pump, and occupied by a kind of turbine-wheel shown in the detached view *E* (same figure). *F* is the stationary boss with spiral flanges *l*, which give the water a twist just as it enters upon the action of the wheel, which has six vanes, as seen in the view *E*. *a* is the base of the pump, cast in one piece with the case *c*, to which is attached by flanges the conducting-case, composed of two parts *d d'*, forming a spiral discharge-passage *q* and *e*; gradually enlarging to the outlet *f* is the stuffing-box, through which passes the driving-shaft *g*; this having turned in its surface at *j*, a series of grooves, which are accurately fitted in a Babbitt metal-box in the standard *h*, counteracting any tendency to end-thrust or vibration. *i* is the bed-plate, having cast upon it the standard *h*, and brackets to which the pump is secured by the flanges and base. When required to be run vertically, no bed-plate is used, but the pump is secured by the base. The base also forms a flange, to which

Fig. 1217.



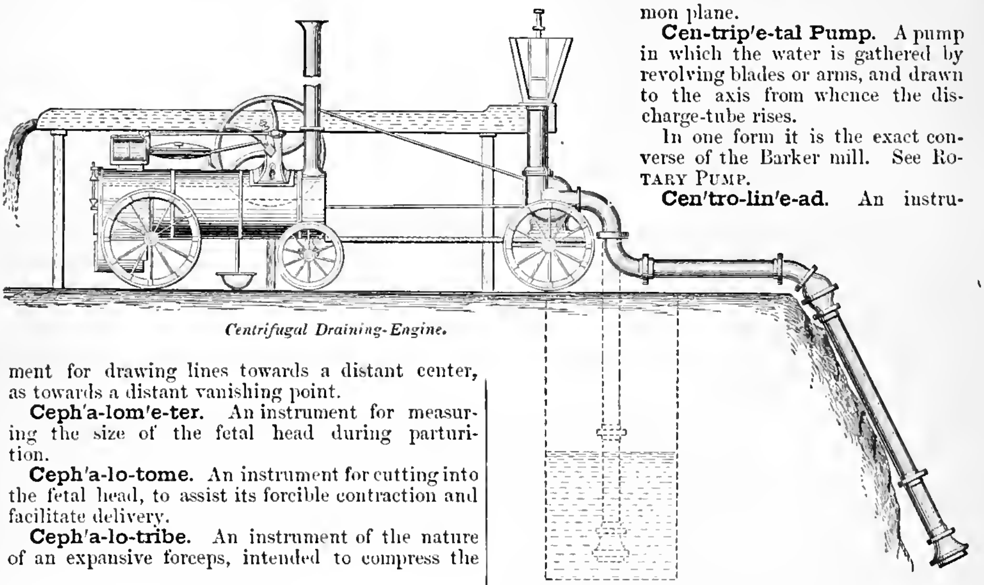
Centrifugal Pump.

is bolted the bend q of the suction-pipe, which has a foot-valve at its lower end. Motion is communicated by a belt upon the pulley p.

Fig. 1217 gives an exterior view of a centrifugal pump.

Fig. 1218 shows the centrifugal pump, with portable engine connected, as arranged for pumping out a pond, or pumping from a river with a shelving bank, the dotted lines showing it as adapted for pumping out of a cistern or well. The pump is placed upon a two-wheeled carriage firmly attached to the engine when working, and driven by a band from the fly-wheel of the engine.

Fig. 1218



Centrifugal Draining-Engine.

Cen-trip'e-tal Press. A mechanical contrivance for pressing inwardly on a radial line from all directions in the common plane.

Cen-trip'e-tal Pump. A pump in which the water is gathered by revolving blades or arms, and drawn to the axis from whence the discharge-tube rises.

In one form it is the exact converse of the Barker mill. See ROTARY PUMP.

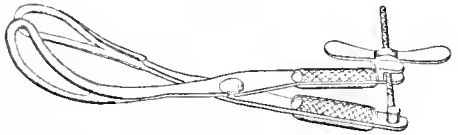
Cen'tro-lin'e-ad. An instrument for drawing lines towards a distant center, as towards a distant vanishing point.

Ceph'a-lom'e-ter. An instrument for measuring the size of the fetal head during parturition.

Ceph'a-lo-tome. An instrument for cutting into the fetal head, to assist its forcible contraction and facilitate delivery.

Ceph'a-lo-tribe. An instrument of the nature of an expansive forceps, intended to compress the fetal head and facilitate delivery. It has to a considerable extent superseded the *crochet* and *perforator.*

Fig. 1219



Lusk's Cephalotribe.

The instrument depicted has blades with a cephalic curve, which gives it power as a compressor, and grasp as a tractor.

Ce-ram'ics. All varieties of work formed of clay, in whole or in part, and baked, are included under this name. See BRICK; TILE; ENAMEL. See also specific list under POTTERY AND CLAY.

It is distinguished from *vitrics*, in which silex predominates, the result being glass.

Ce'ra-to-tome. A knife used in dividing the cornea.

Ce-rau'no-scope. An instrument to imitate lightning and thunder.

Cere-cloth. Waxed cloth; formerly used as a shroud in embalming. Hence *cerements.* See EMBALMING.

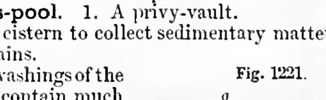
Cer'iph. (*Printing.*) The fine lines of a type or letter at the top and bottom, projecting beyond the heavy strokes. The terminal cross-lines of a letter. Also called hair-lines.

Ce'ri-um. A heavy, grayish-white metal, but little known or used.

Ce'ro-graph. A writing on wax.

Cer'vix-di-la'tor. An instrument which is used for dilating the cervix uteri when contracted, particularly the internal os. After the point is thrust in, the handles are pressed together, which expands the blades.

Fig. 1220.



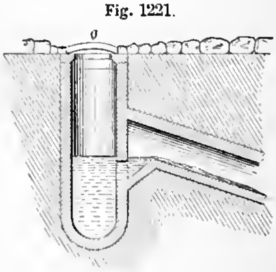
Cervix-Dilator.

Cess-pipe. A pipe for carrying off waste water, etc., from a sink or cesspool.

Cess-pool. 1. A privy-vault.

2. A cistern to collect sedimentary matter passing into drains.

Fig. 1221.



Cesspool.

The washings of the streets contain much gravelly and sandy *débris*, and during rain-storms other articles are carried through the open or grated entrance g to the sewers. Such things are collected in the cistern or cesspool, and the water flows off beneath the trap-wall, which prevents the upward passage of mephitic air and gases. See CATCH-BASIN.

Chaf'er. A small portable furnace. *Chaffer; chauffer.*

Chaf'er-y. A forge in an iron-mill, wherein the iron is wrought into bars.

Chaff-cut'ter. A machine for chopping or cutting long feed, such as hay, straw, or stalks, into chaff, in which condition it may be fed in a box or bag, dusted with bran or meal. An economical and compact mode of feeding. See STRAW-CUTTER.

Chaff-halt'er. A lady's bridle with double reins.

Chaf'ing-dish. 1. A pan of coals to heat a dish. 2. A dish heated by lamp or jet beneath.

Chaf'ing-gear. (*Nautical.*) *Parceling* or *serving* on ropes, to keep them from being chafed by running rigging.

Chain. 1. A device consisting of several associated links, joined endways so as to string out in line.

The varieties of chains are numerous, and their names are derived from their (*a*) material, (*b*) structure, or (*c*) purpose, as, —

a. Gold, steel, galvanized iron, etc.

b. Twisted link, flat link, etc.

c. Top-chain, curb-chain, surveyor's chain, mooring-chain, etc.

Chains in olden times had three purposes.

(1.) They were worn as emblems of investiture or badges of office, as in the cases of Joseph and Daniel, in Egypt and Babylon. The idea was preserved in Persia, and blossoms yearly in the civic ceremonies wherein London rejoices that she has found another mayor.

(2.) For ornament. Necklaces, girdles, and ankle-chains were used by various nations of antiquity. Jewels were worked into the links or strung upon cords. To the chains which hung from the neck, fancy or fashion suspended cowries, mirrors, "round tires like the moon," trinkets, amulets, emblems, and scent-bottles. The Midianites, who invaded Palestine in the time of Gideon, ornamented with chains the necks of their camels. The modern uses of ornamental chains are numerous and familiar.

(3.) For confining prisoners. Before and after the time when poor Samson was blinded and then bound with fetters of brass, when David lamented Abner, and the fugitive Jedekiah, after defending his capital for two years, became a fugitive, was captured, blinded, bound with chains of brass, and carried to Babylon, chains, fetters, and manacles were the lot of captives and criminals. Peter slept "between two soldiers bound with two chains," being, no doubt, handcuffed to his guards on either side. Herod, of course, had the soldiers killed, which was the ordinary punishment of a Roman guard who allowed his prisoners to escape.

The Romans used chains with links of various patterns; circular, oval, figure-8, horse-shoe, bars with eyes, etc. These were principally of a small size and ornamental character. Their cable was of rope, as it was with us until a few decades since. Xerxes thrashed the Hellespont with chains, and then threw chains into the strait as a reminder; but the bridge he built was of rope, supported by ships, and sustaining the planks on which the host crossed.

Twisted chains are mentioned by the Greek authors.

Iron for chains is cut off with a plain chamferer; each piece is then bent, introduced, and welded. In common chains the weld is made at the small end, called the *crown.*

In chain cables the weld is at the side of the oval, the *scarf* being flatways of the link. The parts and consecutive forms are shown at *i*, *j*, *k* (Fig. 1222).

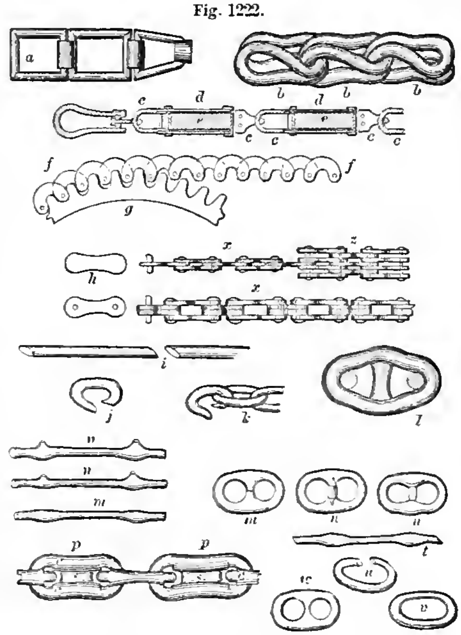
Curbed or twisted chains are welded in the ordinary manner and twisted afterwards; each link as it is welded, or a few made hot at a time and twisted.

Chains with flat links are made in the fly-press. The links are cut out, of the form shown at *h*. The holes are afterwards punched as in washers, one at a time, every blank being so held that its circular extremity touches the stops on the bed or die, which insure the centrality of the blank and punch. The two holes are thus made equidistant in all the links, and are afterwards strung together by inserting wire rivets through the holes.

The pins or rivets for the links are cut off from the length of wire in the fly-press, by a pair of cutters like wide chisels with square edges, assisted by a stop to keep the pins of one length; or by one straight cutter and an angular cutter hollowed to about 60°, or by two cutters, each hollowed to 90°. In the three cases, the wire is respectively cut from two, three, or four equidistant parts of its circumference.

Sometimes the succession of the links of the chain is one and two links alternately, as at *x*; or three and

Fig. 1222.



Chains

two, or four and three, as at *z*, up to eight and nine links, which is sometimes used. The wires when inserted are slightly riveted at the ends.

Chains intended to catch on pins or projections on the periphery of a wheel are made two and two, as in the other figure, leaving an opening which slips over the cog.

Mr. Oldham, the engineer to the Bank of England, contrived a curved link-chain *f f*, adapted to work in connection with a cog-wheel *g*, with epicycloidal teeth.

Chains for watches, timepieces, and small machinery are too minute to be made as the ordinary flat-link chain. The slip of steel is first punched through with the rivet-holes for a number of links, by means of a punch in which two steel wires are inserted; the distance between the intended links is obtained (somewhat as in file-cutting) by resting the burrs of the two previous holes against the sharp edge of the bolster. The links are afterwards cut out by a punch and bolster of a minute size. The punch has two pins inserted at the distance of the rivet-holes; the slip of steel being every time fitted by two of the holes to these pins, all the links are thereby cut centrally around these rivet-holes.

The tools are carried in a thick block having a perpendicular square hole, fitted with a stout square bar; the latter is driven with a hammer, which is supported by pivots raised by a spring and worked by a pedal. When the links measure from $\frac{1}{4}$ to $\frac{1}{2}$ inch in length, the press is worked by a screw.

The punches are fitted to the side of the square bar, in a projecting loop or mortise, and are secured by a wedge. They are drilled with holes for pins, and across each punch there is a deep notch to expose the reverse ends of the pins, in order that, when broken, they may be driven out and replaced. The pins are taper-pointed, that they may raise burrs, instead of cutting the metal clean out; and, being taper, no puller-off is required, and the bed-tools are fitted in chamfer-grooves in the base of the instrument.

A pocket chronometer-chain 14 inches in length, containing in every inch of its length 22 rivets and 33 links, in 3 rows, has 770 pieces, and weighs $9\frac{1}{2}$ grains.

A chain for a small pocket-watch measures 6 inches in length, has 42 rivets and 63 links in every inch, in all 630 pieces; and the whole chain weighs $1\frac{3}{4}$ grains.

Chains for jewelry are cut with punches. The exterior and interior of each is frequently rectangular; each alternate link is slit with a fine saw for the introduction of two contiguous links, and the slit is soldered up.

Rigging-chain is usually of the open-linked kind, with oval links. It is described by stating the diameter of the rod of which the links are made.

The outside breadth of a chain is about $3\frac{1}{3}$ times the diameter of the rod of which it is made.

a a (Fig. 1222) is an open-linked chain with thimbles for the engagement of the pins of a sprocket-wheel in water-elevators.

b b are the links of a chain of bent loops made without cutting or welding.

c c are the links of an elastic chain, in which blocks of india-rubber are so placed as to be compressed by a pull on the chain.

m n n are forms of Acraman's chain, 1820, in which the bar is rolled with protuberances which form by mutual contact an actual stay, or form sockets for stay-pins.

p p are links of Sowerby's chain-cable, 1822, which are bent inward at the middle, where they are stayed by a block *s*, secured by a riveted pin. The projections *c c* are to prevent entanglement of the links.

HAWKS's English patent, 1828, has links made of iron rolled with enlargements which correspond to the ends of the links where the greatest amount of friction occurs.

The illustration shows —

A *link-blank*, *t*, the edges cut off with a *scarf*.

The link bent, *u*.

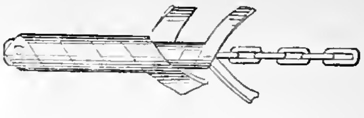
Welded, *v*. Stayed, *w*.

2. The surveyor's chain (Gunter's) has 100 links, each of which is $7\frac{92}{100}$ inches in length; the whole measuring 4 rods, equal to 66 feet. See SURVEYOR'S CHAIN.

3. (*Weaving.*) The *warp*-threads of a *web*. Also known as the *chain, filling,* or *twist*; and in silk as *organzine*.

Chain-belt. A chain forming a band or belt for the conveyance of power.

Fig. 1223.



Chain-Belt.

A chain covered with piping or overlaid with strips to form a round belt.

Chain-boat. A substantial boat used in harbors in recovering chain-cables and anchors.

Chain-bolt. 1. (*Shipbuilding.*) A bolt to secure the chains of the dead-eyes through the toe-link as a fastening for the shrouds.

One of the bolts fastening the channel-plate to the ship's side.

2. One having an attached chain by which it may be drawn back, falling by its own gravity or pushed into place by a spring. Used with high doors of rooms or book-cases.

Chain-bridge. 1. A form of ferry-bridge in which the passage is made by chains laid across the river and anchored on each side, and moving over chain-wheels on board, driven by engines. Such a ferry-bridge used to cross the Itchen River, Hampshire, England. The chain pier of Brighton was erected in 1822. The chains of Hungerford Bridge, London, were moved to Clifton, near Bristol, and now span the Avon. The span is 720 feet; hight above water, 260 feet. See FERRY-BRIDGE.

2. An early (for Europe) form of the suspension-bridge in which catenary chains supported the floor. The first was erected over the Tees, in England, in 1741. Rods with eyes and connecting-links were used by Telford on the Menai Suspension Bridge, 1829; steel wires laid up (not twisted) into cables are now used. See SUSPENSION-BRIDGE; FRONTISPIECE.

Chain-bond. The tying together of parts of a stone-wall by a chain or iron bar built in.

Chain-ca'ble. (*Nautical.*) A chain adapted to use as a cable in holding a ship to its moorings or anchor.

The ancient Greeks used rushes; the Carthaginians the *spartium* or broom of Spain and Libya (Africa); the Egyptians, papyrus.

The ancient maritime people, the Veneti, used iron chain-cable for their ships in the time of Julius Cæsar.

In the tenth century the nations of the Baltic used ropes of twisted rawhide thongs. The latter were used in Britain till the third century, and are yet used in Western Scotland for boats and draft.

Chain-cables were used by the Britons. (CÆSAR.) They were common long ago in small sizes, but were only lately made for heavy craft.

They have shackles at every 15 fathoms, sometimes swivels at $7\frac{1}{2}$ fathoms.

Chain-cables were made in England by machinery in 1792, and introduced into the British merchant-service by Captain Brown of the "Penelope," West India merchantman, 400 tons burden, 1811. The cable had twisted links.

BRUNTON patented the stay in the middle of the link. See CHAIN.

The chain-cable was introduced into the British navy in 1812.

In making chain-cables, the bar of 1, $1\frac{1}{2}$, or 2 inch iron is heated, and the scarf is made by a cutting-

CHAIN BRIDGE.

Plate IX.

OVER THE RIVER DNEIPER, AT KIEFF, RUSSIA.

See page 518.

machine ; an oblique cut on the end of the rod, giving a *chamfer* or lap to the cut surfaces, brings a larger surface of the iron into welding contact. The link is formed by inserting the end of the heated bar within a loop in the edge of an oval disk, which may be compared to a chuck, fixed on the end of a lathe-mandrel. The disk is rotated by steam-power, and makes exactly one revolution, when it throws itself out of gear. The heated end of the iron rod thus receives an oval loop, which is detached from the rod by a *chamfered* or oblique cut, making the second scarf for the link and the first scarf for the next link. The link is now concatenated, closed together, and transferred to the fire, the loose end being carried by a traverse chain. When properly heated, it is transferred to the anvil, welded and dressed off between top and bottom tools, after which the cast-iron transverse stay is inserted and the link closed thereupon.

Chain-cables are generally made in lengths of from $12\frac{1}{2}$ to 25 fathoms ; each length is usually provided with a *swivel*. The lengths are joined together by *shackles* (which see).

A cable's-length is 100 fathoms of 6.08 feet each, and is one tenth of a nautical mile.

Chain-cables are stowed in chain-lockers, generally near the mainmast, or just before the engine and boiler compartment. The locker-space required may be found by the following rule : Multiply the square of the diameter of the cable-iron in inches by 35. The product is the space required in cubic feet, nearly.

Four kinds of apparatus are used for regulating or checking the motion of the cable as it runs towards the *hawse-holes ;* and for holding on by the cable after the anchor has taken hold.

These are CONTROLLERS ; BITTS ; STOPPERS ; COMPRESSORS (which see).

Chain-coup'ling. (*Railroad Engineering.*) 1. A supplementary coupling between cars, as a safety-device in case of accidental uncoupling of the prime connector.

2. A shackle for a chain whereby lengths are united as in a chain-cable, or a shackle or clevis to unite a chain with an object.

Chain-fast'en-ing. A sailor's bend, or cable mooring. The upper figure shows the *double* chain-fastening ; the lower one the *single* chain-fastening.

Fig. 1224.

Chain-Fastenings.

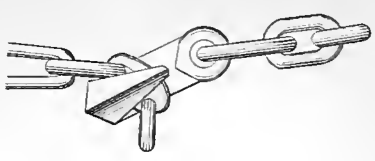
Chain-gear. A form of cog-gearing in which an open linked chain catches up the cogs or sprockets of the wheel, and is the means of motion thereof, or conversely. See CHAIN-WHEEL.

Chain-guard. (*Horology.*) A mechanism in watches provided with a fusee, to prevent the watch being overwound.

Chain, Gun'ter's. The surveyor's chain, having 100 links, each $7\frac{92}{100}$ inches in length ; total length 4 rods, equal to 66 feet. See SURVEYOR'S CHAIN.

Chain-hook. (*Nautical.*) 1. An iron rod with a handling eye at one end and a hook at the other for handling the chain-cable.

Fig. 1225

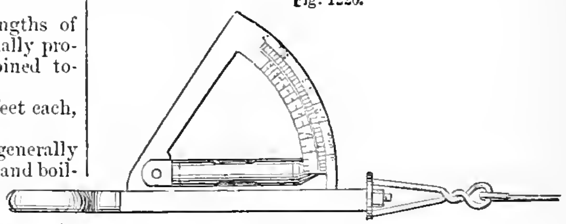


Chain-Hook.

2. A cable-stopper which clamps the link of a chain between two other links, as in Fig. 1225.

Chain-in'cli-nom'e-ter. A form of level in which the inclination of the surveyor's chain is indicated on a scale by the pointer on the end of the level.

Fig. 1226.



Chain-Inclinometer.

Chain-knot. 1. A succession of loops on a cord, each loop in succession locking the one above it, and the last one locked by passing through it the end of the cord.

2. A kind of knot used in splicing. See KNOT.

3. The loop-stitch of some sewing-machines. See STITCH.

Chain-lift'er. (*Nautical.*) A cast-iron grooved rim, with projections, situated at the foot of the capstan-barrel, and forming the drum around which the chain-cable is wound in weighing anchor.

Chain-lock'er Pipe. (*Nautical.*) The iron-bound opening or section of pipe passing through the deck, and through which the chain-cable passes to or from the locker in which it is stowed.

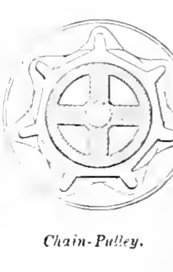
Chain of Locks. (*Hydraulic Engineering.*) A succession of lock-chambers, the lower pair of gates of each of which (except the lowest) forms the upper pair of gates for the chamber below. See CANAL-LOCK.

Chain-pin. (*Surveying.*) The wire pin, having a loop at one end and pointed at the other, employed by surveyors for marking the termination of each chain in measuring distances.

Chain-plate. (*Shipbuilding.*) One of the plates of iron bolted below the *channels*, and serving for the attachment of the dead-eyes to which the shrouds and back-stays are secured.

Chain-pul'ley. One having pockets or depressions in its periphery, in which lie the links, or alternate links, of a chain which passes over it and gives motion thereto, or conversely.

Fig. 1227.



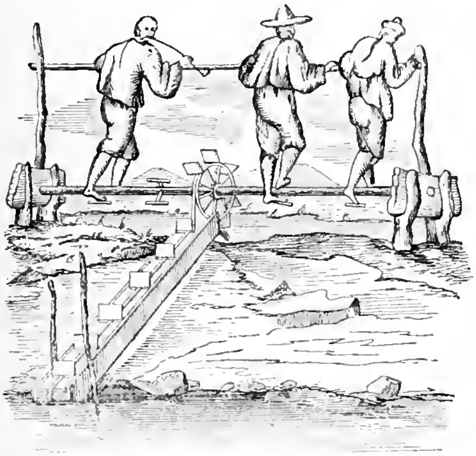
Chain-Pulley.

Chain-pump. One form of the *chain-pump* consists of an endless chain passing around a wheel above and descending into the water below.

In its upward course it passes through a vertical tube whose lower end is submerged, and at whose upper end the water is discharged. Along the chain are round disks or buttons, which fit in the bore of the tube, and form pistons which elevate the water as the chain ascends in the tube. The cellular pumps are of this kind, and when packed pistons are used, they are termed *paternoster pumps*, from the resemblance of the chain and buttons to the rosary.

The chain-pump is a common irrigating-device in China. The barrel is turned by men by means of a treadmill, or by a buffalo, which rotates a large hori-

Fig 1228.

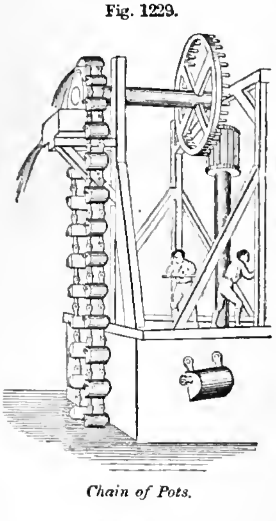


Chinese Chain-Pump.

zontal wheel connected by cogs with the axis of the roller over which the chain runs. The chute is inclined, and the buckets are square boards attached at intervals along the chain. Small machines are turned by hand in the manner of a grindstone, a plan so familiar in our ordinary chain-pumps.

The chain-pump is sometimes called the *Spanish noria*, but improperly. The *Spanish noria* has a pair of chains or ropes between which buckets or pots are secured, dipping water at the bottom and discharging at the top. They have no pistons or ascension-tube, but are like one very common form of the noria of Palestine. The rope of the latter, however, owing to the poverty of the people, is made of withes of myrtle branches.

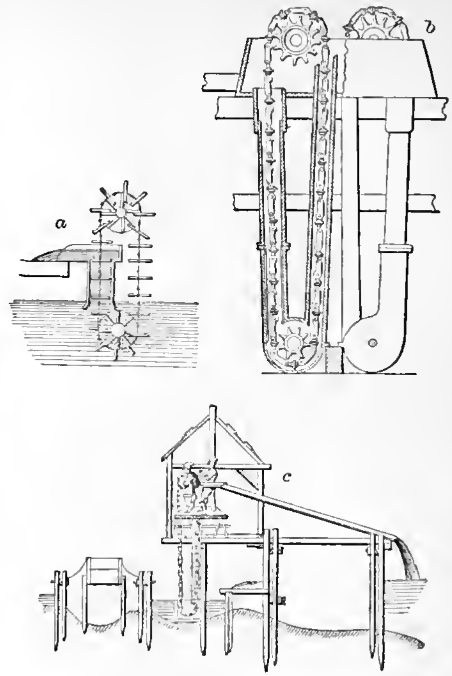
Fig. 1229.



Chain of Pots.

The familiar domestic chain-pump (*a*, Fig. 1230) acts by continuous rotation of a crank. The disks on the chain fit as nearly as may be in the stock which they ascend, and thus lift the water in a continuous stream. In practice, these disks are like buttons, and form links in the chain, which is galvanized to prevent rusting. The tubing is made of some light

Fig. 1230.



Chain-Pumps.

wood and in two longitudinal pieces, the hollow being cut half in each piece, and the sections nailed or bound together.

The axis of one wheel is supported on the curb, and the other on a post in the bottom of the well, or on a scantling lowered from above.

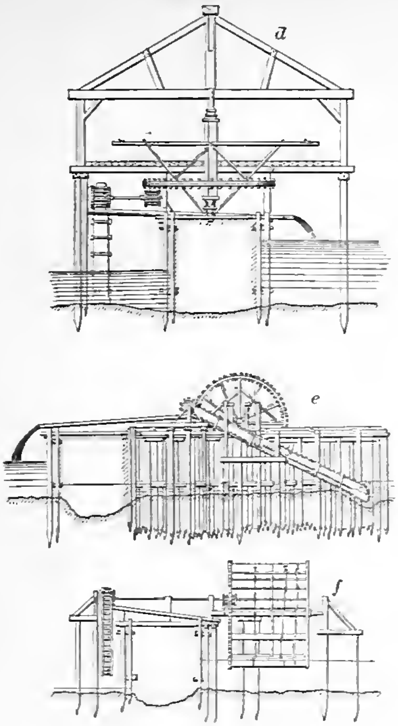
The chain-pump *b* was first used in the British navy on board the "Flora," in 1787. As now used in the English navy, it is formed of a long chain which carries disks at intervals, and passes over sprocket-wheels above and below; the chain passes down a tube called the back-casing, dips into the limber where the bilge-water collects, and up through another tube at whose summit is a cistern. The upper sprocket is turned by a crank, and the tube is made of wood lined with brass. The links are of iron, and each piston consists of two circular brass plates inclosing disks of leather. The upper delivery is into a pump-dale, which conducts the water over the side of the ship.

The *chain-pumps (chapelets)* used by the architect Perronet, to drain the coffer-dams of his bridges at Orleans and elsewhere, were worked by manual, horse, and water power, and are described in Cresy's Encyclopædia of Civil Engineering. The bucket-wheel he used at the bridge of Neuilly is described under NORIA.

The tube of the hand-worked chapelet *c* was vertical, 12 to 18 feet in length, 6 inches in diameter. Four men worked the winches, and were relieved every two hours. They made from twenty to thirty turns in a minute, according to the depth; 500 cubic feet of water were raised per hour, $4\frac{1}{2}$ feet of the chain being wound round at each revolution.

Another of Perronet's chain-pumps (*d*), used at the bridge of Orleans, was worked by horse-power, twelve at a time being employed, and making 140

Fig. 1231.



Chain-Pump.

turns per hour. The pallets acted as buckets, and passed at the rate of 9,660 per hour.

The same master-wheel drove two separate chapelets, with the power above stated; the duty referred to being accomplished by each.

e is a section, and *f* an elevation, of another of Perronet's chapelets driven by a water-wheel.

Chains. (*Nautical.*) Iron bars bolted to the sides of the vessel and holding the *dead-eyes*, to which the lower ends of the shrouds are connected.

Top-chains are sling-chains for the lower yards.

Chain-saw. 1. (*Surgery.*) A saw whose teeth are jointed links, used in making sections in deep-seated places by passing the saw around the bone and then back again, so as to give command of both ends to the operator, who draws the ends back and forth.

Fig. 1232.

Chain-Saw Carrier

2. One form of band-saw or scroll-saw is also made of separate teeth pivoted or hooked together.

Chain-saw Car'rier. (*Surgery.*) A hinged and hooked instrument whereby the end of the chain-saw, or a ligature, by which the saw may be drawn, is passed beneath a deep-seated bone, and so far up on the other side as to be grasped by a forceps.

Chain-shot. A shot formed of two hemispheres or spheres connected by a chain. Invented by Admiral DeWitt, 1666. Formerly much employed for carrying away rigging in naval actions. They were sometimes fired from a cannon with two slightly diverging barrels, united at the breech, forming a single chamber, and discharged through a single vent.

Chain-stitch. 1. An ornamental stitch resembling a chain.

2. (In sewing-machines.) A *loop*-stitch in contradistinction to a *lock*-stitch. It consists in looping the upper thread into itself, on the under side of the goods; or using a second thread to engage the loop of the upper thread.

The *double-chain* stitch of the Grover and Baker machine is made by a lower thread which engages two loops of the upper thread.

One form of the Wilcox and Gibbs machine makes a double-loop engagement with but a single thread. See STITCH.

Chain-stop'per. (*Nautical.*) A clamp or compressor to keep a cable from veering away too fast, or to lock it.

Chain-tim'ber. 1. A timber of large dimensions placed in the middle of the hight of a story, for imparting strength.

2. A bond timber in a wall.

Chain-tow'ing. A plan for canal-boat propulsion. A chain or wire rope, five eighths of an inch in diameter, is laid on the bottom of the water-course, but passes longitudinally over the deck of the boat to be drawn. It there winds upon or around a wheel, or clip-drum, five feet in diameter, the revolutions of which draw the boat by a pull upon the chain, this being lifted at the bow and let down at the stern of the vessel as the latter progresses. The free movement of the chain is provided for by making the two ends of the boat quite low, sloping nearly to the water, while the center, where the drum is situated, is elevated to a considerable hight. The motive-power is supplied by a steam-engine moving its crank-shaft, connected with the axle of the drum by suitable spur-gearing.

The chain system is now in use on the Danube, on the Charleroi Canal, in Belgium, the Beveland Canal, in Holland, and the Terneugen Canal, connecting Ghent with the Scheldt. It is about to be adopted on the Rhine, to facilitate the passage of Bingen Rapids, and on the Upper Elbe.

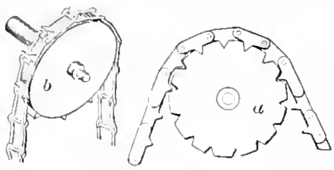
The chain-towing system was first tried in France in 1732 by Marshal Saxe, in transporting war-material. One end of the rope was fastened at a point in advance, and the other passed round the drum of a horse-windlass on board the boat. When the fast end of the rope was reached, the boat was moored until the rope was adjusted for another pull. Nearly a century after this — in 1820 — a modification of the plan was put in regular use on the Rhone. The boat carried a steam-capstan arranged to wind alternately two ropes. Two tenders were provided to accompany the boat. The capstan, winding one rope as in the former case, drew the boat forward and at the same time unwound the other rope upon one of the steamers, which, moving in advance, fixed it for being wound in its turn as soon as the end of the other was reached.

The grand points to be reached by this device are to avail steam as a motor and save the necessity of tow-paths. Modifications of the system have long been in use on our western rivers, and they are navigated successfully by a wire rope which passes over a drum, and is payed out over the stern, as just stated. See TOWING.

Chain-wales. (*Shipbuilding.*) One of the *wales* or thick planks bolted to the ship's sides and serving for the attachment of the *chains* to which the shrouds are connected. *Channel.*

Chain-wheel. The sprockets on the wheel are adapted to receive the links of the chain successively.

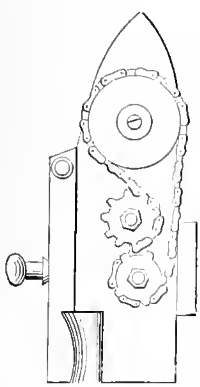
Fig. 1233.



Chain-Wheel.

The power may be communicated by the wheel to the chain, or conversely. The former is shown in the familiar chain-pump, and the latter in machines where the operation is inverted; the column of water pressing upon the buttons attached to the chain and causing them to descend in the tube, thereby rotating the wheel.

Fig. 1234.



Chain-Wheel.

De Vaucauson's chain-pulley was notched on its perimeter and worked in connection with a chain having toothed links.

Another form (*b*) is an open-linked chain acting in connection with a *pin-wheel* or *sprocket-wheel.*

Fig. 1234 shows the application of a chain to driving several wheels in different directions.

Chain-work. A style of textile fabric consisting of a succession of loops, and including hosiery and tambour-work.

Chair. 1. A movable seat provided with a back and adapted for one person.

The names of chairs depend upon structure, material, and purpose: —

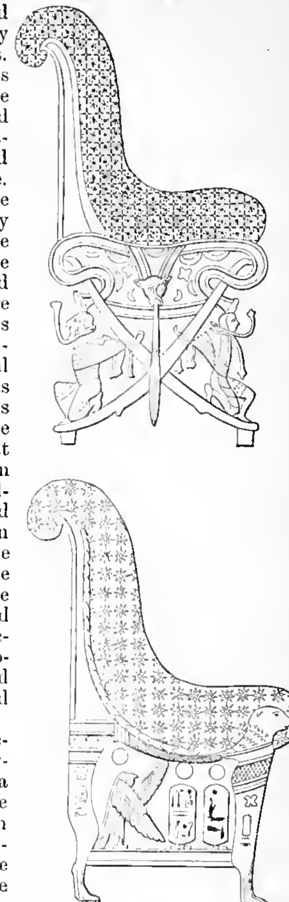
Barber's-chair.	Pew-chair.
Bath-chair.	Photographic-chair.
Camp-chair.	Railway-chair.
Dentist's-chair.	Reclining-chair.
Enema-chair.	Revolving-chair.
Folding-chair.	Rocking-chair.
Invalid-chair.	Sedan-chair.
Locomotion-chair.	Sleeping-chair.
Metallic-chair.	Surgeon's-chair.
Nursery-chair.	Tailor's-chair.
Obstetrical-chair.	Travelling-chair.
Office-chair.	Wire-chair.

Several of which are considered under their alphabetical heads.

The Egyptians were probably among the first people to make chairs. The originality and taste of this grand nation were stupendous and glorious. On the tombs at Thebes, Alabastron, and elsewhere, but especially the former, are found chairs of almost all kinds which modern ingenuity has revived. Thrones, couches, sociables, folding, reclining, lazy-back; leather-seated, cane-seated, split-bottom, made of ebony, inlaid with metals and ivory, with carved backs, sides, and legs; with claw-feet and foot-pads, and upholstered with gorgeous coverings resembling the rich stuffs of modern luxury.

Fig. 1235 shows how little in the way of luxury was left to be desired in the chair line. The back consisted of a frame, receding gradually and terminating at its summit in a graceful curve supported from without by perpendicular bars. Over the chair was placed a handsome pillow of colored linen or wool, painted leather, or gold and silver tissue. The upper figure has an elaborately carved frame, the legs of which are formed of crossed swords, to which are tied captive figures of different nationalities. The brutal mode of tying was common among this people, as may be seen by looking at the drawings in Champollion, Roselline, Lepsius, and the "Description de l'Egypte." The original colors of the chair-frames are blue and gold and red and gold respectively; of the upholstery, red and gold and blue and gold.

Fig. 1235.



Egyptian Fauteuils (from the Tombs of the Kings), Thebes, Africa, 1500 *B. C.*

Du Chaillu describes the easy-chair of Obindji, a chieftain of the Ovenga River, in the Gaboon country, Africa. The Ovenga is the name given to the river Fernand Vas, above Goombi, and was traversed by the enterprising traveler Paul B. Du Chaillu, who walked in the land of the Gorillas a distance of 8,000

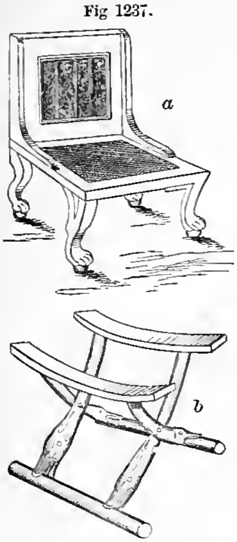
Fig 1236.

Obindji in his Easy-Chair; Gaboon, Africa. A. D. 1873.

miles; shot, stuffed, and brought home 2,000 birds, killed 1,000 quadrupeds, bringing home 80 skeletons and 200 stuffed skins. As an interesting item having no relevance to the subject of chairs, it may be mentioned that he took over fourteen ounces of quinine in curing himself of fifty attacks of African fever.

The Egyptians were an Asiatic race, and it may be assumed, both from the probabilities of the case and from the frequency of the squatting posture in their paintings and bas-reliefs, that the introduction of the chair came in the progress of refinement.

Fig 1237.



Egyptian Chair and Stool.

In Fig. 1237, *a* represents a chair now in the museum of Leyden. The back and legs are of wood, the seat has a wooden frame and interlacing leathern thongs. The seat is only 13 inches high. In some, the interlaced material is cord. Beneath the feet are blocks or pads, probably to prevent noise in moving the chair on a marble floor.

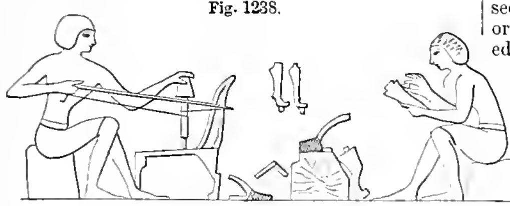
b is a stool made on the principle of our camp-stools. It is in the collection of Mr. Salt, and probably had a leather or leopard-skin cover. The same collection has an ebony stool, inlaid with ivory. The cushion is of leather, and is ornamented.

Many other illustrations might be given, did room permit; but we must be content with referring the reader to Wilkinson's "Customs of the Ancient Egyptians," and to the magnificent work on Egypt, on which the labor and enthusiasm of the French *savans* was so liberally bestowed early in the present century. A copy is in the Congressional Library in Washington, and other copies are probably to be seen in some of the libraries in the large cities. It is an immense and voluminous work.

The elaborate chairs referred to are on plate 89, Vol. II. of the plates, "Description de l'Egypte."

In a tomb of the time of Thothmes III., the Pharaoh of the Exodus, 1490 B. C., is a painting showing a couple of carpenters at work making

Fig. 1238.



Egyptian Chair-Makers (from Thebes).

chairs. One of them is using a bow-drill to bore holes in the seat for the braces of the back-posts, and the other is engaged finishing a leg, scraping it with a plate or sharp instrument in a delicate manner, as the artist is careful to inform us by showing three fingers of the man's hand in a raised position. The tenon on the upper end of the chair-leg is clearly shown in the one he is holding, and also in the two against the wall and that leaning against the post. The artist has also introduced two adzes and a square. The blades of the adzes are lashed to the helve, as was usual with them. None of their axes, hatchets, or adzes had eyes, but the blades were secured by being partially inserted into the helve or stock, and fastened by pins or thongs, or both. In most cases the metal was bronze; in some it is shown to be iron or steel, being colored blue to indicate that metal, red representing bronze.

The Egyptian chairs and stools were from $10\frac{3}{4}$ to 28 inches high, — quite a range, but probably some were intended for the children, others to be used with footstools.

A four-legged stool, with a seat revolving on a bronze pivot, is preserved in the British Museum. The chair is inlaid with ivory, and the seat is of maroon-colored leather.

"Cambyses, in consequence of the venality of the judge, slew and flayed Sisamnes, and, cutting his skin into strips, stretched them across the seat of the throne whereon he was wont to sit when he heard causes. He then appointed Otanes, the son of Sisamnes, to be judge in his father's room, and bade him never forget in what way his seat was cushioned." — HERODOTUS, V. 25.

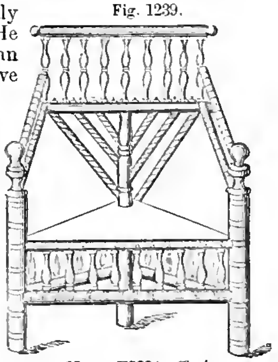
"The heroes of Homer sit at their banquets, and do not lie down. And this was the case at the feasts of Alexander the King, as Dures says. For he once, when giving a feast to his captains, to the number of 6,000, made them sit upon silver chairs and couches, having covered them with purple covers. And Hegesander says that it was not the custom for any one to lie down at a banquet, unless he had slain a boar which had escaped beyond the line of nets." — ATHENÆUS.

The fashion of reclining at banquets came from Persia.

> "And what can for tired limbs compare
> With the soft and yielding Thessalian chair?"
> CRITIAS, quoted by Athenæus (A. D. 220.)

Fig. 1239 shows the chair of that "every inch a king" who was "Defender of the Faith" 350 years ago, and "Head of the Church" about thirteen years afterward. He did not suit everybody in either capacity. He was a better king than some better men have been.

Fig. 1239.



Henry VIII.'s Chair.

2. (*Railway.*) A foot-piece or base-plate for a railway-rail, by which it is secured to the sleeper or cross-tie. The edge-rail, as at first constructed, needed such a support to give it stability; the T-rail with a broad foot-flange may be spiked directly to the sleeper. See RAILWAY-CHAIR.

3. (*Vehicle.*) A kind of carriage. Originally a sedan; now a small carriage for a single person, an invalid. A *Bath*-chair.

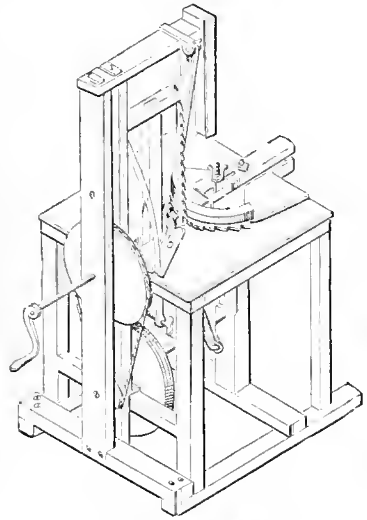
Chair-back Ma-chine'. These machines may be band or jig-saws, which cut out the curved back-piece which is placed on the top of the pillars of the chair-back. Molding or rounding machines for chair-backs have a holder for the stuff, which is moved against a rotary cutter of peculiar shape, the stuff traveling in a prescribed path, so as to receive the conformation desired.

Scraping, dressing, and polishing machines for chair-backs are similar in their mode of presentation of the stuff, but differ in the character of the tool or appliance to which the work is presented.

Chair-bolt. A screw-bolt for fastening down rail-chairs to the sleepers.

Chair-mak'er's Saw. 1. A diminutive form of the ordinary frame-pit saw, in which the blade is

Fig. 1240.



Chair-Stuff Sawing-Machine.

strained by buckles and wedges. The work is clamped to the bench while sawing.

2. A scroll-saw especially adapted for getting out chair-stuff, such as backs and legs which have curves which cannot be readily bent, or of stuff which cannot be readily bent to shape.

Chair-or'gan. (*Music.*) A *choir*-organ placed in a separate case in front of the great organ and at the back of the performer.

Chair-seat Bor'ing-ma-chine'. Machine for the systematic and rapid boring of the small vertical holes in a chair-seat frame, to be occupied by the strips of cane or rattan, or the larger holes for the pillars and spindles of the back.

Chair-seat Ma-chine'. These include the planing-machines, by which the wooden bottoms of chairs are rounded out. The depth of penetration is governed by side guides, which raise and lower the bed relatively to the revolving cutter, or the latter relatively to the bed which carries the chair-seat. Lenman's machines for hollowing chair-seats have a pattern seat over which a governing ball is moved, determining the depth of penetration of the rotary cutter beneath, as it passes over the chair-seat stuff.

Machines are also constructed for cutting grooves in chair-seat frames for upholstering purposes, or to receive the chair-seat which is pressed into the frame.

Chair-spring. A spring underneath the hinged seat of a chair, which gives it a certain resilience, and encourages a tilting or rocking motion.

Springs are sometimes placed beneath the front legs to give a tilting motion.

Chair-web. A kind of saw. A scroll-saw.

Chaise. A vehicle with shafts and two high wheels, and a calash top. The body is supported by thorough-braces, and the elasticity resides in the long shafts and the bed-supporting bars which extend upwardly and backwardly therefrom. It is said that Augustus Imperator contrived this mode of hanging a carriage-body, and so was the inventor of the chaise. It is all the spring yet known to several kinds of Italian vehicles.

Chaise-cart. A light cart with springs, used in various light employment, where goods and parcels are to be expeditiously conveyed.

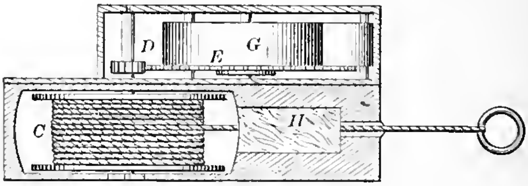
Chal'co-graph. An engraving on copper or brass.

Chal'ice. A cup. The drinking-vessel which holds the wine of the communion service.

Chalk-line. A cord rubbed with chalk or similar material, used by artificers for laying down straight lines on the material as a guide for a cutting instrument.

The Japanese use a wooden cup with a sponge saturated with india-ink, and having holes back and front through which the line passes. At one end of

Fig. 1241



Chalk-Line Holder.

the line is a small awl, and this he sticks in the work at one end of the proposed line, then steps back and lets the line pay off the reel, passing through the ink in the cup. He then snaps the line, and walks back reeling up the line.

Somewhat similar is our chalk-line holder, in which the cord passes from the reel *C*, through the block of chalk *H*, and is automatically rewound by the spring in the barrel *G* and the train of gearing *E D*.

Chalk-line Reel. A spindle or barrel on which a chalk-line is wound. See CHALK-LINE.

Chal'lis. (*Fabric.*) An elegant dress article of silk warp and worsted yarn; introduced in 1832. It is made on a principle similar to the Norwich crape; only thinner and softer, and having a pliable and clothy dress instead of a glossy surface.

Cham'ber. 1. The place where a charge of powder is lodged in a fire-arm, cannon, mine, or blast-hole. Howitzers and mortars have sub-caliber chambers.

2. (*Hydraulic Engineering.*) The space between the gates of a canal-lock.

3. (*Vehicles.*) An indentation on the inner surface of an axle-box, to hold grease.

4. An apartment where sublimed objects are deposited, as sulphur, lamp-black, arsenic, zinc-white, mercury, and other condensible fumes.

5. (*Dyeing.*) A form of apparatus for steaming printed cloths, to fix the colors. (See STEAM-COLORS.) It is about 12 × 9 feet, and 9 feet high, the interior furnished with frames which run in and out upon rollers when the front door is open. The frames have cross-rods provided with tenter-hooks for suspending the cloths.

6. (*Founding.*) *a.* The portions of a mold which contain the exterior form, and which are closed over the core in casting hollow-ware.

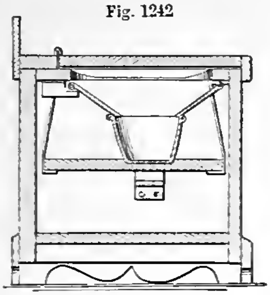
6. An inclosed space, as the *fire-chamber* of a furnace.

7. A short piece of ordnance for making a noise at celebrations.

8. The part of a pump in which the bucket or plunger works.

9. A urinal for the bedroom.

Fig. 1242



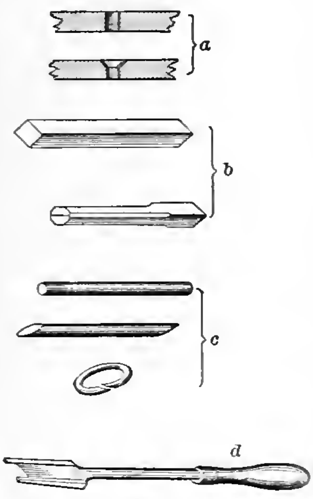
Chamber-Closet.

Cham'ber-clos'et. A commode or night-chair for invalids and the infirm. The seat has a funnel which enters the urinal, and india-rubber packing prevents the escape of effluvia. See EARTH-CLOSET.

Cham'ber-gage. (*Ordnance.*) One used in verifying the size of a howitzer or mortar-chamber.

Cham-bray'. (*Fabric.*) A kind of gingham; plain colors, linen finish, ladies' dress-goods.

Fig. 1243.



Chamfers.

Cham'fer. A bevel or slope conferred upon an edge which was originally rectangular.

a, chamfered hole to receive a screw-head.

b, a chamfered pin.

c, a chamfered rod, ready for welding into a link.

d, harness-maker's chamfering-tool.

Cham'fer-ing-bit. A boring-tool with a conical cutter adapted to chamfer the edge of a hole to enable it to receive the head of a screw. See BIT.

Cham'fer-ing-tool. (*Saddlery.*) A tool (*d*, Fig. 1243) for paring down the thickness of a leathern strap near the edge, making a chamfer.

It is called *thinning* the edge, and is sometimes preliminary to sewing, and at other times to fitting the edge into its place in the harness.

Cham'fret. 1. (*Carpentry.*) A groove or furrow.

2. A bend produced by cutting off the edge of a right angle. See CHAMFER.

Cham'fret-ing. (*Building.*) The splay of a window, etc.

Cham'ois. (*Shammy; chamois-leather.*) The name indicates that this leather is made from the skin of the chamois (*Rupicapra tragus*), but the skins of sheep, goats, deer, calves, and the split hides of other animals, are used for the making of this kind of leather; the superior kinds of which are called *chamois*, and the inferior, *wash-leather*.

The skins are unhaired in a lime-vat, and scraped on a beam in the ordinary way. The lime is removed in a bath by lactic or acetic acid, and the skins are then *frizzed*.

This process consists in rubbing the skins with pumice or the blunt end of a round knife, until the grain is removed, the skin softened, and reduced to an even thickness throughout.

The skins are then pressed to expel water, fulled by wooden hammers, spread, treated with oil, — fish-oil being preferable, — rolled up and again fulled, to distribute the oil throughout the bundle. They are then taken out, unfolded, dried, re-oiled, and again rolled and fulled. These processes are repeated till the effect is fully accomplished, heat being applied during the latter portion, by means of suspending the skins in a store-room.

Superfluous oil is removed by a short steeping in a dilute alkaline lye; the skins are then wrung, dried, suppled by stretching, and polished by rolling.

Cham-pign'on-rail. (*Railroad Engineering.*) One having a rounded upper surface.

Chan'cel. That part of the choir, or eastern part of a church, between the altar or communion-table and the rail that incloses it.

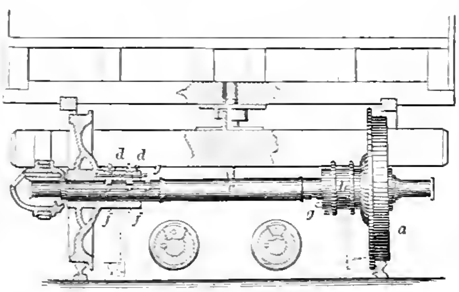
Chan-de-lier'. A frame with branches to hold candle-sockets. The word now includes a frame with gas branches, though the latter is technically a *gasalier*.

A chandelier in the palace of the Khalif of Cordova, A. D. 1100, contained 1,084 lamps. Cordova was then the intellectual center of Europe, and the royal dwellings of Germany, France, and England were like stables.

2. An obsolete term for a movable frame of fascines to cover a working party.

Change'a-ble Gage-truck. A means of adjusting wheels to different gages of tracks, by making the wheels adjustable on the axles. The arrangement is shown in Fig. 1244; one wheel in section, the other in elevation. The two views below the truck are sections transversely of the axle. The wheels are cast with an elongated hub or sleeve *b* projecting inwards, in which there are two slots, and in the axle there are corresponding recesses which admit of the wheels being firmly fixed to the axle by means of V-shaped wedges or blocks *d d*. Two india-rubber bands or rings *f f*, fitting tightly, are placed over the openings in the sleeve, thus holding the wedges in position; and they are farther secured by a split-pin with curved ends, which is passed lengthwise through the sleeve and wedges, and expands at the inner end in an enlarged opening. As an additional security, also, there is a set-screw *g* passing through the sleeve, which is made to press upon the split-pin, thus preventing the possibility of the latter ever being jerked or shaken out whilst

Fig. 1244



Changeable Gage-Truck.

running. The gage is changed by merely removing the wedges, and then passing the wagons over a converging or diverging track, as the case may be, and the usual time occupied in changing is from five to ten minutes for each car.

Change-pump. A pump introduced by the successors of Boulton and Watt in connection with the boilers of sea-going vessels, in order to keep a continual change in the body of water, removing the super-salted water and substituting sea water.

The change-pump has been superseded by the blow-off cock, which, being turned at intervals, allows a portion of the super-salted water to escape overboard. External condensation and fresh-water boiler-supply are now the mode.

Change-wheel. (*Machinery.*) *Change-wheels*, having varying numbers of cogs of the same pitch, are used to connect the main arbor of the lathe with the feed-screw, so as to vary the relative rates of rotation and consequently the pitch of the screw to be cut.

The first application of *change-wheels* to a lathe is supposed to have been in a fusee-cutting lathe, described in a work, 1741. The change-wheels are intermediate, and journaled in a bracket, which permits them to be brought into engagement with the rotative and feed wheels respectively. See SCREW-CUTTING LATHE; ENGINE-LATHE.

Chan'nel. 1. (*Shipbuilding.*) *Chain-wale.* A flat ledge of wood or iron projecting outward from the ship's side, for spreading the shrouds or standing rigging at each side of the masts, and protecting the chain-plates. The channels are at the level of the deck beams.

2. (*Nautical.*) The rope track in a tackle-block.

3. (*Boot-making.*) The cut in the sole of a boot to hold the thread and allow the stitches to sink below the surface of the sole.

4. A long groove cut in a stone on a line where it is to be split.

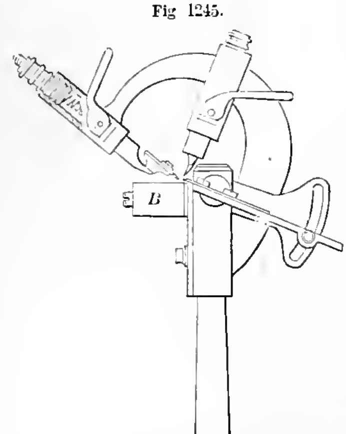
5. (*Mining.*) An air conduit or pipe, to conduct air into a mine.

6. (*Founding.*) A trough to conduct melted metal to the pig-bed or mold.

Chan'nel-ing. (*Architecture.*) Perpendicular channels, or cavities, cut along the shaft of a column or pilaster.

Chan'nel-ing-ma-chine'. 1. (*Boot-making.*) One for cutting the channels in boot-soles, to allow the thread to bury itself in the leather and be protected from immediate wear. It consists of a knife, which makes an oblique cut in the sole, to a gaged depth and regulated as to distance from the sole-edge by a guide.

Fig 1245.

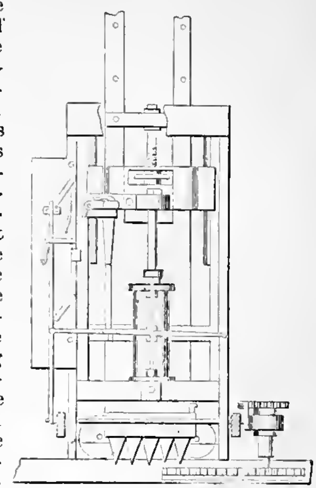


Sole Channeling-Machine.

In the example, the sole rests upon the roller *B* and its edge against the guide; it is then pressed forward against the knives. One of the latter is presented obliquely upon the surface of the sole, and cuts the channel; the other has an oblique (nearly opposite) presentation, and slices off the upper edge of the sole, leaving it beveled.

2. (*Stone-working.*) A machine having a series of jumpers or chisels which make a groove across the face of a block in the quarry, or detached. In the illustration shown, the machine has a gang of cutters operated by direct-acting steam-cylinder. The cutters have direct motion from the piston. The valve is reversed at the blow of the cutters; or, in case of no blow being given, it is reversed before the cylinder-bottom is touched by the piston. The cutter-bar is adjustable on the cylinder-bar, to suit the depth of groove cut. The whole mechanism is mounted on vertically adjustable rollers, and the feed-device is operated from the cross-head.

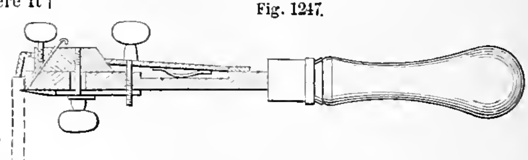
Fig. 1246.



Stone Channeling-Machine.

Chan'nel-ing-tool. A tool used for cutting a channel near the edge of a piece of leather, so as to hide the sewing. Used in making round work, such as running reins, whips; also in sinking grooves in shoe-soles, to hide the stitching. The cutter is adjustable on the shank, for penetration, and the guide at the end to gage the distance of the channel from the edge of the leather.

Fig. 1247.



Channeling-Tool.

Chan'nel-i'ron. 1. A form of angle-iron having a web with two flanges extending only on one side of the web.

2. (*Building.*) A brace or hook to support the guttering.

Chan'nel-wale. (*Shipbuilding.*) One of the strakes between the ports of the gun-deck and upper deck of large vessels.

Chant'er. (*Music.*) The tenor or treble pipe of a bagpipe.

Chant'late. (*Building.*) A projecting part of the roof-sheathing at the eave, to carry the drip clear of the wall.

Chap. A *check* of a vise. One of the *jaws*. *Chop.*

Chape. 1. The catch or piece by which an object is attached,—to a belt, for instance; as the piece of leather known specifically as the *frog*, to which a bayonet-scabbard is attached, and which slides on the belt; or a piece used to fasten a buckle to a strap or other piece of leather.

2. A plate on the back of a buckle, or the bar of a buckle, by which it is attached to a belt.

3. The hook of a scabbard.

4. The plate at the point of a scabbard. The *tip*.

Chap'el-et. 1. (*Hydraulic Engineering.*) *a.* A dredging or water-raising machine, consisting of a chain provided with scoops or scuttles, or with pallets traversing in a trough; the chain moving over rollers or wheels, of which the upper one is driven by power, and the lower one is vertically adjustable so as to regulate the position of the scoops or pallets, to bring them against the mud to be lifted, or to submerge them in the water to be raised. See CHAIN-PUMP; DREDGING-MACHINE.

b. A French name for the chain-pump in which the cushions or buttons which occur at intervals on the chain are compared to the beads of the rosary. Hence also known as *paternoster* pumps.

2. (*Saddlery.*) A pair of straps with stirrups, joined at the middle and secured to the frame of the saddle.

Chap'let. (*Architecture.*) A small molding decorated with round or oblong beads or other similar forms.

Char'coal. Charcoal consists of wood burned with but little access of air. Billets of wood are built into a heap, which is covered with earth or sand. The heap is fired at openings left near the bottom of the pile, and the gases escape at small openings above.

For making fine charcoal, such as that of willow, used in the manufacture of gunpowder, the wood is burned in iron cylinders, or rather retorts, in which a process of destructive distillation removes the volatile hydrocarbons, pyroligneous acid, etc. By this more perfect means the process is accurately regulated.

Charcoal is used in the arts as —

A fuel. A polishing powder.

A table on which pieces of metal are secured in position to be soldered by the blow-pipe.

A filtering material.

A defecator and decolorizer of solutions and water.

An absorbent of gases and aqueous vapors.

A non-conducting packing in ice-houses, safes, and refrigerators.

An ingredient in gunpowder and fire-works.

In the galvanic battery and the electric light.

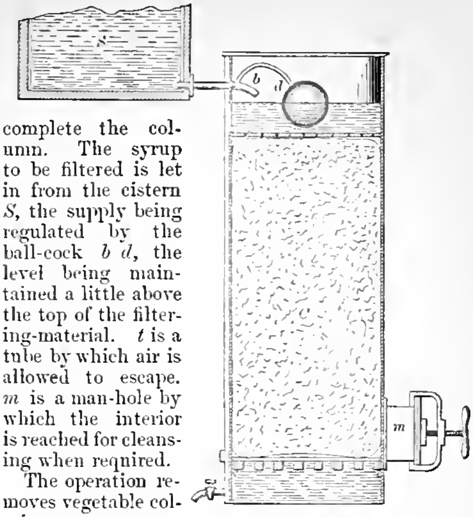
Char'coal, An'i-mal. (*Sugar-refining.*) Animal charcoal is prepared by calcining bones in closed vessels. These are either retorts, similar to those in which coal is distilled for the production of illuminating gas, or they are earthenware pots piled up in kilns and fired. Charges of fifty pounds of bones to a pot will require, say, sixteen hours of firing. The bones are then ground between fluted rollers, the dust removed, and the granulated material used for charging the filters of the sugar-refiner. The material is used for removing color, feculencies, and fermenting ingredients from the syrup. See BONE-BLACK FURNACE.

Char'coal-cool'er. A wire cylinder in which animal charcoal is agitated and cooled, after revivifying, while a current of air carries off the noxious gases.

Char'coal-fil'ter. A filter charged with ordinary or animal charcoal for domestic use, or with animal charcoal for use in the sugar-house or refinery.

The filter for the removal of feculent and other matters held in suspension in the clarified cane-juice is a high cylindrical vessel charged with bone-black. Upon the perforated bottom a filter-cloth is spread, and upon this a layer of bone-black is tightly packed; over this the main body of animal charcoal *C* is piled in loosely. Another cloth and a perforated plate complete the column. The syrup to be filtered is let in from the cistern *S*, the supply being regulated by the ball-cock *b d*, the level being maintained a little above the top of the filtering-material. *t* is a tube by which air is allowed to escape. *m* is a man-hole by which the interior is reached for cleansing when required.

Fig. 1248.

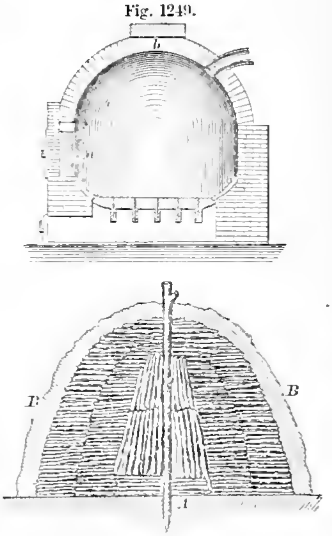


Charcoal-Filter.

The operation removes vegetable coloring-matter, excess of lime derived from the clarifying, mineral salts, and particles in a fermenting stage.

Char'coal-fur'nace. A furnace for producing charcoal by the dry distillation of wood, and for the collection of the tar and pyroligneous acid resulting therefrom.

Fig. 1249.



Charcoal-Furnace.

The air passes in between the bars of the grate, and is regulated as to quantity by a closely fitting ash-pit door. The wood is built in at the openings *a b*, and the charcoal extracted at *a*. When sufficient heat has been obtained, the access of air is prevented, and the carbonization proceeds, the volatile matters passing off at the neck above, to be collected and separated. The lower figure shows the mode of building a charcoal-heap. *A* is the central post, *B* an earthen covering.

Char'coal-point. A pencil of carbon prepared for use in the electric-light apparatus.

Charge. 1. The body of ore, metal, fuel, or other matter introduced into a furnace at one time, for one heat, or one run, as the case may be.

The *charge* of a puddling-furnace is about 500 pounds of pig-iron, and this forms 4 blooms.

The *charge* of a gas-retort is 220 pounds, introduced in two scoopfuls of 110 pounds each.

The *charge* of a tumbling-box is as many castings or other matters as it will conveniently contain and give room for mutual attrition.

The *charge* of an amalgamating pan is according to size. They vary from 4½ to 6 feet in diameter; some work off two tons in twenty-four hours, others a *charge* of 1,400 pounds in three or four hours.

And so on.

2. The amount required to furnish an implement or machine for a single operation; as, —

The *charge* of a gun. The *service-charge* for smooth-bored guns may be ⅓ to ¼ the wei ht of the projectiles. For *hot-shot* and *ricochet* firing these charges are reduced. Rifled guns, avoiding windage, require a smaller charge than smooth-bores. The service-charge of the Armstrong gun is one eighth the weight of the projectile.

In the navy three charges are used: *distant, full,* and *reduced.*

The weight of a gun ranges in smooth-bores from 500 to 700 times, and in rifled guns from 600 to 800 times, the weight of the service-charge of powder.

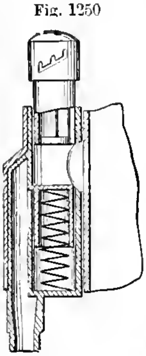
The weight of the carriage (shipboard) is about one fifth that of the gun. The weight of the spherical shot is about four times that of its service-charge; and of cylindrical shot, eight times. The weight of the cast-iron sphere, in pounds, is equal to the cube of the diameter, in inches, multiplied by 0.134 nearly. Weight of a steel sphere, in pounds, is equal to cube of diameter, in inches, multiplied by 0.148 nearly.

The explosive energy of gunpowder completely burned is estimated at from 240,000 to 300,000 foot pounds, per pound of powder. Owing to incomplete combustion, and other causes of loss, its energy communicated to cannon-shot is considered to be from 144,000 to 192,000 foot pounds, per pound.

The velocity is thus calculated: —

"Divide the energy due to the powder by the weight of the shot; the quotient is a hight in feet which is to be multiplied by 64.4; the square root of the product will be the initial velocity of the shot in feet per second." — RANKINE.

Fig. 1250



Gun-Charger.

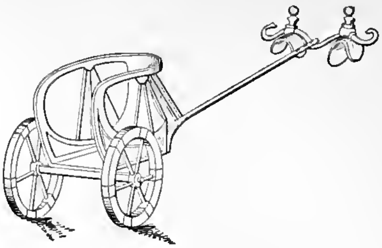
Char′ger. 1. (*Mining.*) A spiral instrument for charging horizontal blast-holes.

2. A device for dropping into the bore of a fowling-piece from a shot-belt or pouch a gaged quantity of shot. By forcing down the plunger the communication with the pouch is closed, and the charge is allowed to pass to the tube, which conducts it to the gun. The piston-head is adjustable, to vary the capacity of the charge-chamber.

Char′i-ot. 1. An ancient two-wheeled vehicle, drawn by horses attached to a pole, and used in state processions, in warfare, and for racing.

The Egyptian chariot was light, made principally of wood, and rested on an axle upon which the wheels were secured by linch-pins. In many cases, however, it would appear that the wheels were fixed to the axle, which turned with them. The floor of the car was sometimes made of latticed thongs, to give it a certain amount of elasticity to the rider, who always stood, unless he sat on the edge, as the car had no seat. The body was strengthened with leather and metallic bands. The pole was inserted into the middle of the axle, and rested in front upon saddles which bore upon the withers of the horses and were secured in place by collars and belly-bands. The chariots had invariably two wheels, which were strengthened at the junctions of the fellies by bronze bands and bound with metallic tires. In some cases

Fig. 1251.

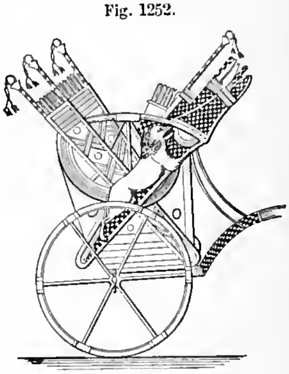


Egyptian Chariot (Wilkinson).

the fellies appear to have been made by bending a single strip around a former. The pole, according to Homer, was about 13½ feet long, and the yoke was attached to it by a strap and a pin, and sometimes was connected by a single trace to a part nearer to the chariot. No double traces are noticed.

The accompanying cut shows the war-chariot with all its rigging, bow-cases, quivers, and maces. The arrangements are graceful, and the ornamentation is florid. Chariots represented on the ruins at Persepolis are the same in essential points of construction. The horses are hitched by a yoke to the carriage-pole, the saddles resting on the withers, as before stated in regard to the Egyptian mode.

Fig. 1252.

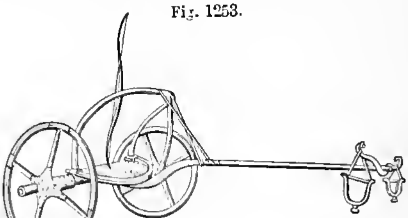


Egyptian War-Chariot (from Thebes).

A four-wheeled hearse occurs on several of the tomb-paintings in Egypt. See HEARSE.

Fig. 1253, from Wilkinson, represents an ancient Scythian car actually found in Egypt and preserved in the Florentine Museum. It is believed to have

Fig. 1253.



Scythian Chariot.

been taken as a spoil from Scythia by the Egyptian conqueror.

War-chariots do not appear in any Egyptian monuments prior to the eighteenth dynasty.

The price of an Egyptian chariot in the time of Solomon was 600 shekels of silver, about $300; an immense price, considering the then value of money.

The first horses and chariots are represented at Eileithyias at the time of Ames or Amosis, about

1510 B. C. They do not appear to have been used in Egypt during the time of the Osirtasens.

Herodotus says that "the Greeks learnt from the Libyans to yoke four horses to a chariot" (IV. 189). It is, however, mentioned by Homer (*Iliad*, viii. 185; *Odyssey*, xiii. 81).

In the Assyrian chariots a spare horse was sometimes attached by a single inside trace to the chariot. The Lydians, it is said, had sometimes several poles to their chariots and horses between each. This resembles the modern shafts. The origin of shafts, however, must be looked for in another direction. In the primitive form, shafts consisted of a pair of poles attached by girth and breast-band to the sides of a horse and dragging behind. The load was laid upon the rear end. Thus the North American Indians move their lodges.

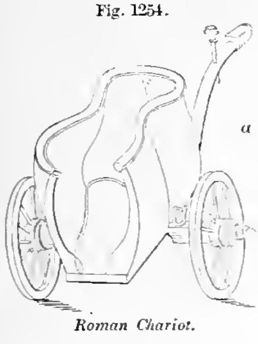
In the triumphal procession of Ptolemy Philadelphus were: —

24 chariots drawn by 4 elephants each.
60 chariots drawn by 2 goats each.
12 chariots drawn by antelopes.
7 chariots drawn by oryxes.
15 chariots drawn by buffaloes.
8 chariots drawn by 2 ostriches each.
7 chariots drawn by gnus.
4 chariots drawn by 2 zebras each.
4 chariots drawn by 4 zebras each.

On all these animals rode boys wearing wide-awake hats (*petasi*).

The chariot of the Greeks and Romans had two wheels, and but one pole usually, although some of the Lydian chariots had two or even three poles.

Fig. 1254.



Roman Chariot.

The body had an elevated forward portion, answering to our *dash-board*, and called the *antyx*. The annexed cut *a* is from an ancient chariot preserved in the Vatican. The body was sometimes of light open-work, or even of wicker.

The pole was the sole means of draft, and was mortised into the axle. Two horses were always used. If more were added, each was attached by a trace on the side towards the pole-horses. The yoke was attached by a pin to the pole, and rested just in front of the withers of the horses. They pulled by the yoke, which was secured by breast-bands and surcingles to the animals. See HARNESS.

This mode of drawing was universal. The lateral horse had a collar, from whence the trace passed to the rim of the car.

One exception, perhaps, must be made. It is possible that the Roman *cisium*, a kind of gig, had shafts, and was drawn by one horse.

The axle was usually of oak, but sometimes of ilex, ash, or elm. The body was secured thereto, and to the pole, which was mortised into the axle and braced or strengthened by irons. The spindles or arms of the axle were of wood; no *skeins*, so far as we are informed.

The wheels revolved on, not with, the axles, and were secured by linch-pins. They consisted of nave, spokes, fellies, and tire, all usually of wood. We read of bronze tires, but they were exceptional. The fellies were bent.

The ancient Britons were celebrated for their skill and prowess in chariot-warfare. Their chariots were open in front instead of behind; the poles were wide, and the charioteer ran out upon the pole and discharged his javelin (*cateia*), even standing upon the yoke, and then retreating to the car.

The skill of the ancient Britons in chariot-driving filled Julius Cæsar with astonishment. See CARRIAGE; CART.

Chariot-wheels of bronze are preserved in the Berlin Museum, and one of wood of ancient Egypt is in the Abbott Collection, New York Historical Society.

2. The modern chariot is a stately four-wheeled pleasure-carriage having one seat.

Char'i-o-tee'. A four-wheeled pleasure-carriage having two seats covered by a calash-top.

Char-kan'a. (*Fabric.*) A checked Dacca muslin.

Char-ov'en. A furnace for carbonizing turf.

Char'ring-chis'el. A broad nigging-chisel, used in *charring* or hewing stone.

Chart. 1. A representation of a portion of the earth's surface projected on a plane. The term is commonly restricted to those intended for navigators' use, on which merely the outlines of coasts, islands, etc., are represented.

2. A sheet exhibiting a statement of facts in tabular form, so arranged that any particular may be readily referred to.

Hipparchus, of Alexandria (160 – 125 B. C.), reduced geography to a science, determining the latitude and longitude of places by celestial observations.

The geography of Ptolemy was translated into Arabic by the command of the Khalif Al Maimoun, between 813 and 833 A. D.

Charts were introduced into the marine service by Henry, son of John I. of Portugal, about A. D. 1400; brought to England by Bartholomew Colon in 1489.

Mercator's chart is a projection of the surface of the earth in the plane, with the meridians parallel to each other, the degrees of longitude all equal, and the degrees of latitude increasing in a corresponding ratio towards the poles. It was introduced by Gerald Mercator in 1556.

The principle of its construction had, however, been previously explained by Edward Wright.

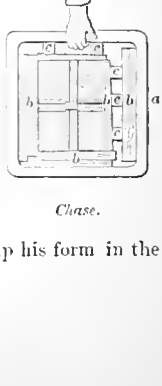
The first computation of longitude from the meridian of Greenwich Observatory was in 1679.

The first magnetic chart was constructed by Dr. Halley, in 1701. It was limited to the Atlantic and Indian Oceans.

Char-tom'e-ter. An instrument for measuring maps and charts.

Chase. 1. (*Printing.*) A rectangular iron frame (*a*, Fig. 1255) which receives the matter from a *galley*, and in which it is arranged in columns or pages, and *locked up* in order for printing. *Rules* (if necessary) and *furniture* for spacing the pages are placed between the pages, and all locked firmly in the *chase* by wedges *c c c*, called *quoins*.

Fig. 1255.



Chase.

The *furniture*, *b b b*, consists of slips of wood or metal, half an inch in thickness, and of any required length.

Those at the head, foot, and side are called *head-sticks*, *foot-sticks*, *side-sticks*. Those between the pages are called *gutters*.

Gutenberg used screws to lock up his form in the chase. Quoins came later.

2. (*Ordnance.*) *a.* The portion of a gun forward of the *trunnions* to the *swell* of the muzzle. In modern guns, the *swell* is suppressed, and the *chase* extends to the *muzzle.*

b. A *chase*-gun is one mounted at the bow to fire at a vessel being chased. It is fired from a *chase*-port.

3. (*Masonry.*) A groove cut in the face of a wall.

4. (*Shipbuilding.*) A kind of joint by which an *overlap*-joint gradually becomes a *flush*-joint, as at the hooding-end of *clinker-built* boats. A gradually deepening rabbet is taken out of each edge at the lands, so that the projection of each strake beyond the next below it gradually diminishes, and they fit flush with each other into the rabbets of the stem and stern post.

5. A groove, trench, or passage of a given width and depth to fit an object which traverses or fits therein ; as, —

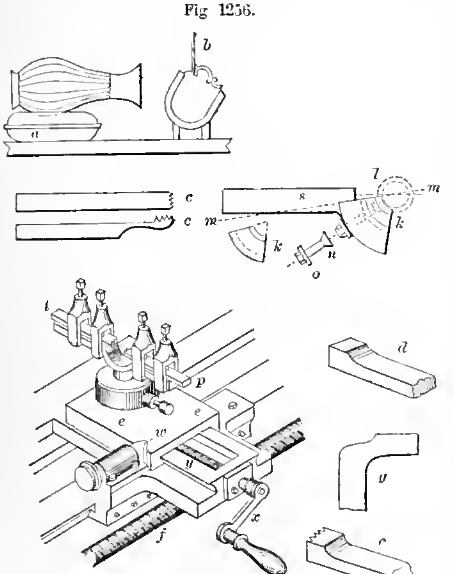
The *chase* or curved water-way, or *breast* in which a *breast-wheel* or *scoop-wheel* rotates. The sides of the *chase* fit as nearly as possible to the wheel, to prevent waste of water.

The trench made by spades or machines for the reception of drain-tile.

Chas'er. 1. (*Machinery.*) A tool for cutting threads in the hand-lathe ; sometimes called a comb, from its having a row of projecting teeth (*c c c*, Fig. 1256).

It is made of steel, and the teeth filed by hand or by a cutting *hub.* It is first forged in blank in the form of *d* for an outside chaser, or in the form of *g*

Fig 1256.



Chasers

for an inside chaser. The teeth are then filed or made by a *hub* (which see). The latter is a steel mandrel rotated on the centers of a lathe and having a section of screw-thread cut upon it. The thread is notched in places, so as to make cutting edges.

By holding the edge of the *chaser*-blank against the *hub* the teeth are cut in the former, and it is ready for tempering. It may then be used in cutting or finishing screw-threads on a bolt or rod, or in a socket or coupling, as the case may be, or may be used in making a *hub* on a mandrel of softened steel turned down to the right size and shape.

The chaser is dispensed with in power-lathes, which are provided with trains of gears for varying pitch and with automatic feed, the work being rotated slowly, the chaser supported in a rest, and sliding therewith at a rate determined by the pitch of the feed-screw and the rate of rotation of the work.

In the chasing-engine (Fig. 1256), the cutter *k* is made as a ring of steel, which is screwed internally to the diameter of the bolt *l* which is to be threaded, and turned externally with an under-cut groove, for the small screw *n* and nut *o*, by which it is held in an iron stock *s* formed of a corresponding sweep ; for distinctness, the cutter *k* and screw *n* are also shown detached. The center of curvature of the tool is placed a little below the center of the lathe, to give the angle of separation or penetration. After the tool has been ground away, in the act of being sharpened, it is raised up until its points touch a straight edge applied on the line *m m* of the stock. This denotes the proper hight of center, and also the angle to which the tool is intended to be hooked, namely, 10°. Each ring makes four or five cutters, and one stock may be used for several diameters of thread.

In Shanks's arrangement for *cutting screws* in a lathe, a front and a back chaser are employed, so that one may cut while the slide traverses in one direction, and the other during the return-movement. *p* represents the front and *t* the back tool, which are mounted on one slide *e e*, and all three are moved as one piece by the handle *x*. In the first adjustment, the wedge *w* is thrust to the bottom of the corresponding angular notch in the slide *e*, and the two tools are placed in contact with the cylinder to be threaded. For the first cut, the wedge *w* is slightly withdrawn, to allow the tool *p* to be advanced toward the work ; and for the return-stroke, the wedge is again shifted under the observation of its divisions, and the slide *e* is brought forward towards the workman, up to the wedge ; this relieves the tool *p* and projects *t*, which is then in adjustment for the second cut ; and so on alternately. The command of the two tools is accurately given by the wedge, which is moved a small quantity by its screw and micrometer, between every alternation of the pair of tools, by the screw *y* operated by the handle *x*.

Punches or gravers are used for embossing or engraving the surfaces of metal, the design being in low relief or cut in intaglio. See also Enchasing.

In the embossing by punches, the object is filled with lead or pitch, and laid on a sand-bag *a*, or in a *pitch-block*, while the chasing-tool *b* is held vertically and driven by a hammer. Some portions of the metal are thus driven inward, while those around rise up from the displacement and reaction of the pitch.

The chasing-tools are of various kinds, with flat, rounded faces and curved edges, so as to follow a pattern. Other tools have faces ornamented with designs in cameo or intaglio, which are conferred upon the metal by the action of the punch and hammer.

Chasing by the graver may be merely engraving in lines, but is usually in the form of relief ; parts of the metal being cut away, leaving protuberant portions of ornate form, and which are farther beautified by graver-lines, frosting, milling, etc. The sand-bag supports the work while being chased by the graver.

The art of chasing was much practiced among the Greeks. Two celebrated examples of chasing in iron are : —

The iron base of the vase made by Glaucus of Chios, and dedicated to the Delphic oracle by Alyattes, king of Lydia. This had small figures of animals, insects, and plants.

The iron helmet of Alexander, the work of Theophilus

The principal chasing of antiquity was upon weapons, armor, shields, chariots, tripods, quoits, candelabra, chairs, thrones, mirrors, goblets, dishes.

The art arrived at great perfection in Etruria.

> " But none the golden bowl can chase,
> Or give to brass such varied grace,
> As that renownéd, hardy race
> That dwells by Arno's tide."
> CRITIAS, quoted by Atheoæus (A. D. 220).

2. (*Metallurgy.*) One of the edge-wheels which revolves in a trough, to grind substances to powder. (See CHILIAN MILL; MORTAR-MILL; OIL-MILL.) Also used in grinding ore for puddling-furnaces, etc.

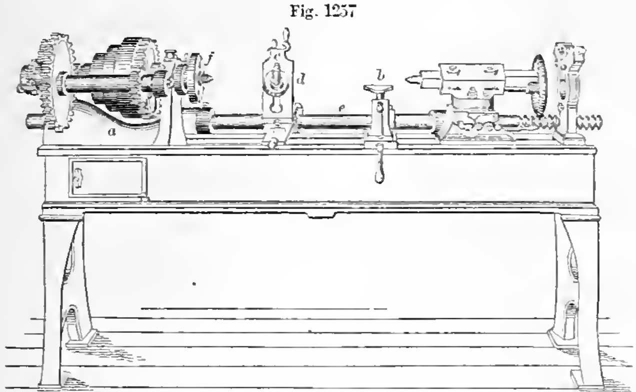
Chas'ing-chis'el. A punch used in enchasing. The mallet by which it is driven is the *chasing-hammer*, and the operation is performed on a *stake*. See CHASER.

Chas'ing-ham'mer. The mallet of the chaser in the operation of enchasing by embossing by punches. (See *a b*, Fig. 1256.)

Chas'ing-lathe. A screw-cutting lathe. So called from the name of the tool wherewith screws were cut by hand in the old form of lathe, before the slide-rest and feed-screw were invented.

In the illustration, which shows Sellers's improved form of lathe for brass work, *a* is the live-head, which is back-geared. The spindle *c*, for holding the chasing-hobs, is so arranged as to accommodate two different pitches at the same time, or to cut with a single pointed tool either single, double, triple, or quadruple threads. The slide-rest *d* for the chaser is carried by a bar *e* at the back of the lathe; the counter-weight to chasing-bar presses either to or from the face-plate *f*; a poppet-head with square spindle and detachable screw for quick motion can be adjusted to any taper when used to carry turning-tools, and is provided with slide-rest movement. *b* is the hand-tool rest.

Fig. 1257

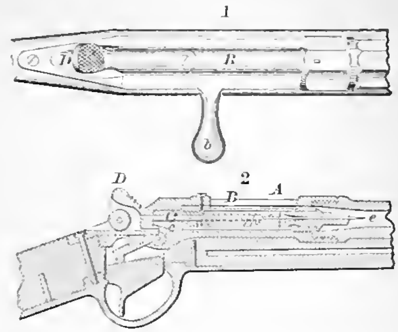


Sellers's Chasing-Lathe.

Chas'ing-tools. Those used by the chaser in the operation of embossing by punches. The work is laid on a chasing stake or cushion, and the punch struck by hammer or mallet. (See *a b*, Fig. 1256.)

Chasse'pot-gun. The breech-loading, center-fire needle-gun of the French service. It was designed as an improvement on the Prussian needle-gun, or *zündnadelgewehr*, to which it was opposed in the Franco-Prussian war of 1871, and derives its name from the inventor. A paper cartridge is employed in the gun as originally constructed in 1867, but in 1869 M. Chassepot patented an improved arrangement, embracing a cartridge-retractor for use with a central-fire metallic cartridge; the construction of the gun is, however, essentially the same.

Fig 1258.

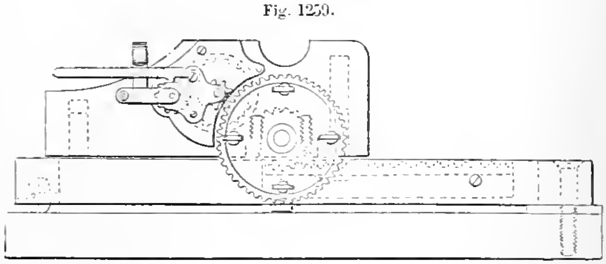


Chassepot Rifle.

An opening on the right of the chamber *A* permits the insertion of the cartridge, which is effected by resting the butt of the gun, held in the left hand, against the left hip, turning the lever *c* from right to left and drawing it back, thus retracting the hollow cylinder or breech-block *B*; the cartridge is placed in the opening thus made, and is pushed home to its seat by a forward movement of the lever, which is then turned back to its original position, locking the breech-block in place. The shaft *C*, contained within the cylinder *B*, carries the needle *e*, and is drawn back by means of the knob *D*, compressing the spring which surrounds the shaft, until a detent thereon engages with the tumbler of the lock, holding the latter in cocked position. Pressure on the trigger allows the spring to act, driving the needle forward, penetrating the cartridge, and exploding the fulminate. A rubber washer at the inner end of the cylinder *B*, through which the needle passes, acts as a gas-check.

Chas'sis. (*Ordnance.*) The base-frame on which

Fig. 1259.



Chassis.

a barbette or casemate gun is run in and out of battery. The chassis is capable of a certain amount of lateral sweep, called *traverse*, so as to adjust the gun horizontally in pointing. This is frequently by oscillating in an arc, a pintle in front of the chassis being the center of oscillation. (See GUN-CARRIAGE.) In the example, the gun-carriage is moved on the chassis by a system of gears operated by a crank; a lateral friction-compressor within the principal spur-wheel being employed to partially resist the recoil of the carriage. A windlass, operating on a toothed bar or rack attached to the chassis, controls the traversing or directing movement.

Chat′e-laine. A lady's waist ornament, with suspended charms, keys, etc.

Chat-roll′er. (*Mining.*) An ore-crushing machine, consisting of a pair of cast-iron rollers, for grinding roasted ore.

Chats. (*Mining.*) The central portion or stratum of a mass of ore in the process of washing.

Chat′ty. A porous earthen water-pot, used in India in refrigerating.

Chauf′fer. A small table-furnace. It may be of iron or of a black-lead crucible, fitted with air-holes and a grate.

Che-bec′. (*Nautical.*) A kind of vessel employed in the Newfoundland fisheries. Named from Chebacco (now Essex), a town in Massachusetts. Also called a *pink-stern.*

Check. 1. (*Fabric.*) A pattern produced by crossing stripes in the warp and the weft. The stripes may be of varying colors, or varying thickness, or both.

2. An East-Indian screen or sun-shade made of narrow strips of bamboo, four to six feet long, with connecting cords, and hung before doors or windows of apartments.

3. A card, plate, or tag in duplicate, used to identify articles placed promiscuously with others. See BAGGAGE-CHECK.

4. (*Music.*) A padded post on the back end of a piano-forte key, used to catch the head of the hammer in its descent and prevent rebounding, which might cause it again to strike the string. It is a feature of the *grand action.*

Check-bar. (*Music.*) A bar which limits the backward play of the jacks. See PIANO-MOVEMENT.

Check-bridge. (*Steam Engine.*) The fire-bridge of a steam-boiler furnace; so called as it was supposed to check the too great freedom of draft which was carrying off the heat.

Check′er-ing-file. A compound file, consisting of two files riveted together, and whose edges project unequally, so that one acts as a *spacer* in checkworking the *small* of gun-stocks, etc. See DOUBLE FILE.

Check′ers. A game played with pieces of two colors on a board of sixty-four squares, whose alternating colors have given it the name of a checkerboard. Also called draughts.

Rameses III., the great Sesostris of Herodotus, is represented, in his palace at Medinet Aboo and in a number of instances, playing at draughts; generally with one of the ladies of his harem. The still older tombs of Beni Hassan (say about 2000 B. C.) have similar representations. The nature of the moves cannot be well determined; the pieces of the respective players are diversely colored. They took each other, for in one figure of Rameses he has a handful of captives from the board. His lady is evidently losing, and is playfully holding a flower to his nose to divert his attention. They are both moving their pieces at once, however.

The pieces were of ivory, bone, or wood, and of the same general form; but some had human heads differing for the respective sides of the board. The largest pieces are about 1⅛ inches high and 1⅛ in diameter.

The checkers of the Greeks and Romans was a game played with pieces, the sets being of different colors and sometimes assuming fanciful shapes. They

Fig. 1260.

Draughts of Sesostris (Thebes).

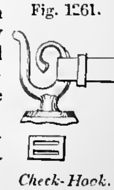
were sometimes pebbles (*calculi*), used as counters on the abacus, and were called by the epithets "thieves," "marauders" (*latrunculi*), "soldiers" (*civiles*), "foes" (*hostes*), etc., indicating that the game represented a miniature combat.

There are indications among the Roman writers, that, in one form of the game, some of the men moved in a certain direction (*ordinarii*), while others had more liberty of movement and were termed *vagi.* This resembles chess. A man inclosed between two others was in *check* (*alligatus*) and was taken from the board.

The *abacus*, in which it was played, was marked with lines or divided into squares. There were, no doubt, several modifications of the game. (See ABACUS.) Sometimes the moves were determined by dice (*tesseræ*), like our backgammon and tric-trac. See DICE.

Check-hook. 1. A device in hoisting and lowering apparatus, designed to stop the motion of the wheel over which the rope runs, if the machinery becomes unmanageable. On the pulley are hooks which fly out by the centrifugal force when the speed becomes excessive, and engage stop-pins which arrest the rotation of the pulley and the descent of the cage.

Fig. 1261.



Check-Hook.

2. (*Saddlery.*) A hook on a gig-saddle for the attachment of a bearing-rein.

Check-line. (*Saddlery.*) The line which branches off from the principal rein. See CHECK-REIN.

Check-lock. A lock so applied to the door as to check or hold the bolts. The bolts of the check-lock do not themselves hold the door, but are the means of detaining the bolts which do.

Check-nut. A secondary nut, screwing down upon the former to secure it. A *jam-nut, lock-nut,* or *pinching-nut.*

Check-rein. (*Saddlery.*) The branch rein which connects the driving-rein of one horse to the bit of the other. In double lines, the left rein passes to the near side bit-ring of the near horse, and a *check*-line proceeds from the said left rein to the near bit-ring of the *off* horse. The right driving-rein passes directly to the off bit-ring of the off horse, and has a *check*-rein which connects with the off bit-ring of the near horse.

The horses of the Egyptian chariots had check-reins.

Check-rein Hook. See CHECK-HOOK.

Check-string. A cord by which the occupant of a carriage signals the driver.

Check-valve. A valve placed between the feed-pipe and the boiler, to prevent the return of the feed-water. See ALARM CHECK-VALVE; BACK-PRESSURE VALVE.

Cheek. One of the corresponding side-plates or parts of a frame or machine; more frequently used in the plural, as —

1. The side-pieces of a gun-carriage on which the trunnions immediately rest; also called brackets.
2. The shears or bed-bars of a lathe on which the puppets rest.
3. The projections on the side of a mast on which the *trestle-trees* rest.
4. The side-pieces of a window-frame.
5. The solid part of a timber on the side of the mortise.
6. (*Founding.*) The middle part of a *three-part* flask.
7. The *branches* of a bridle-bit.
8. The standards or supports, arranged in pairs, of such machines as the Stanhope or copper-plate printing-press, the rolling-mill, and many varieties of presses.
9. The sides of an embrasure.
10. The jaws of a vise.
11. The sides of a pillow-block which hold the boxing.
12. The miter-sill of a lock-gate.

Cheek-block. (*Nautical.*) A block, one side of which is formed by a cheek-piece secured to an object which forms the other side, as in the cheek-blocks near the ends of the yards for the sheets of the square sails. See BOOM-IRON.

Cheek-straps. (*Saddlery.*) Straps passing down each side of the horse's head and connected to the bit-rings.

Cheese. Milk-curd pressed into a shape and ripened.

Hippocrates (460 B. C.) states that the mode of preparing this food from milk was discovered by the Scythians at a very early date. There can be little doubt that it was a common article of food among the pastoral nations of Uz, Canaan and Asia Minor, as well as among the Scythians. The Egyptians, also, had immense herds of kine, goats, and sheep, and the curds of milk, soured naturally or artificially, must have been used. Curds are pressed to remove the buttermilk, and then become cheese. The ripening of cheese develops its flavor. Virgil describes cheese as the common food of the Roman shepherds.

Strabo records a difficulty experienced in former times by the Iberians in the vicinity of Gades (Cadiz): "The excellence of the pasturage is such that the milk of the cattle there fed does not yield any whey, and they are obliged to mix it with large quantities of water on account of its richness. After fifty days' pasturing, it is necessary to bleed the cows to keep them from choking. The pasturage is dry, but it fattens wonderfully." So it would appear.

Cheese is mentioned three times in the Old Testament Scriptures, but each time under a different Hebrew name. It was some coagulated and hardened production of milk. Burckhardt describes it as coagulated and dried buttermilk, ground, and eaten by the Arabs with butter.

Among a pastoral people great are the uses of milk. Cheese forms a staple article of diet to millions who know but little of agriculture. Jesse sent ten cheeses by the hands of David to the captain of the thousand in which the brethren of the latter served (1 Samuel xvii. 18); and "cheese of kine" were brought to David at Mahanaim (2 Samuel xvii. 29), 1023 B. C. Job complains, in his anguish, of his distemper: "Hast thou not poured me out like milk and curdled me like cheese!"

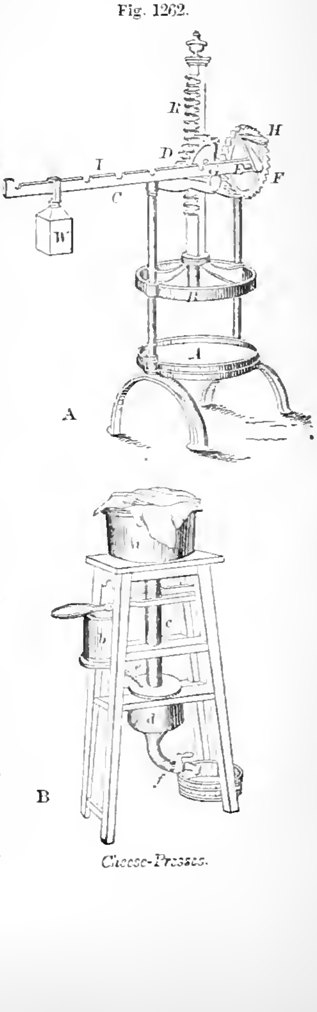
Cheese-cut'ter. A device for breaking the curd into small pieces, that the whey may more readily exude.

Cheese-hoop. An open-ended cylinder, usually of wood, in which curds are pressed, to expel the whey and acquire a form.

Cheese-knife. A large spatula, used in dairies to break down the curd.

Cheese-press. The cheese-press (*A*, Fig. 1262) is constructed of iron. The hoop containing the curd is placed on the bottom-plate *A*, and the upper plate *B* is made to descend upon it. There are two ways of doing this; one quick and easy, until the resistance becomes great, and the other slower and more powerful, and used for the conclusion of the operation.

Fig. 1262.

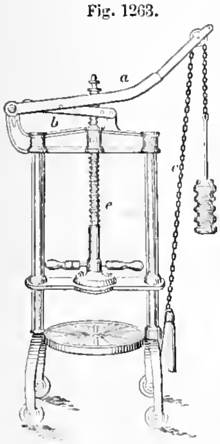


Cheese-Presses.

On the axis *C* of the wheel *D* there is a pinion of eight teeth, which works in the rack *R*. On the axis *E* there is another pinion of eight teeth, which acts in the wheel *D* of twenty-four teeth. This axis *E* may be turned by the crank-handle *H*, three turns of which will make the rack descend through a space equal to eight of its teeth. In this way, the plate *B* may be lowered to touch the cheese, and to commence the pressure; but when the pressure becomes considerable, the second method of acting upon the rack is resorted to. On the axis *E*, besides the pinion before mentioned, there is a fixed ratchet-wheel *F*; the lever *I*, which embraces *F*, is also placed on this axis, but turns freely round it. A pawl or click, turning on a pin, may be made to engage in the notches of the ratchet-wheel *F*. By means of this arrangement, when *I* is raised up, and the click engaged in *F*, the axis *E* and its pinion will be turned round with great power on depressing the end *I* of the lever; and by alternately raising and depressing *I*, any degree of pressure required may be given to the cheese. The weight *W* may be suspended to continue the pressure.

The *Pneumatic Cheese-press* *B*, shown in the lower part of the same figure, consists of a stand about three feet high, on the top of which is a metallic vessel *a*, forming a *hoop* for the curd. This vessel has a loose, corrugated bottom covered with wire-cloth. The bottom of the vessel communicates by a pipe *c* with a receiver *d*, which is exhausted of air by means of an air-pump *b* and pipe *e*.

Fig. 1263.



Cheese-Press.

The curd being salted and placed in a cloth in the vessel *a*, the pump is worked and the pressure of the atmosphere drives the whey down through the curd, and it collects in the receiver, from whence it is discharged, as occasion may require, by means of the pipe and faucet *f*. The curd is then subjected to pressure in the usual manner.

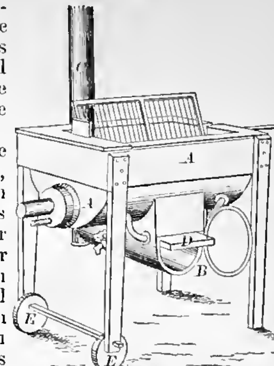
Another form of press involves the use of the toggle, as the leverage increases as the platen descends. The weight is suspended by a chain which runs over the pulley on the end of the long arm of the toggle. A hand lever operates the screw for quick movements.

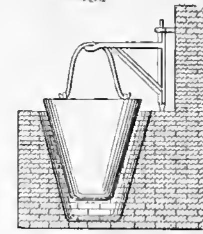
Cheese-shelf. One constructed for holding cheeses during the process of ripening. Ingenuity has been exercised in saving the time in turning the cheeses singly day by day, by inverting the whole shelf with its row of cheeses.

Cheese-turn'er. A shelf capable of being inverted, so as to turn over the cheeses laid upon it, — a daily duty during the progress of the ripening of the cheese.

Cheese-vat. The necessity for preserving a certain temperature in cheese-vats has given rise to numerous devices, among which may be cited that illustrated at *A* in the accompanying cut. The vat *A* is semi-cylindrical and double-walled, water being contained between the shells. Under the vat is a furnace *B*, for heating the water, the smoke from which escapes by the pipes *C*. The degree of heat admitted to the water is regulated by a sliding damper *D*. A coil of circulating pipes is affixed to the outer shell of the vat, connecting with the water space at center and ends of the vat, thus equalizing the heat in the water space. Spouts are attached for drawing off the whey, the water from the water space, and discharging the curd. To aid in this, one end of the machine is set on eccentrics *E*. The wire frame cuts the curds into small blocks, and sweeps it from the inner surface of the vat.

Fig. 1264.



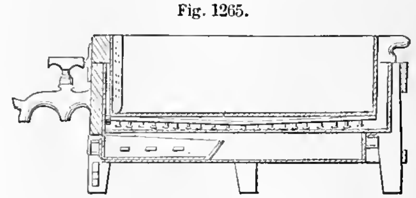


Cheese-Vats.

The vat used on the plains of the Po, where the Parmesan cheese is made, is shown in the lower figure. It is a copper caldron, slung from a crane over a conical fireplace, in which wood is burned. In this vat the milk is heated and coagulated, and without removing is broken by a stick having cross wires. The curd is then again heated, taken out, drained, salted, pressed, and in forty days is moved to the cheese-loft.

In Fig. 1265 the pan is hinged to the vat and rests upon pins within it; the contents are warmed by a furnace beneath; the whey drawn off by a strainer; adjustable legs permit the inclination of the vat.

Fig. 1265.



Cheese-Vat.

Chek'mak. (*Fabric.*) A Turkish fabric of silk and gold thread mixed with cotton.

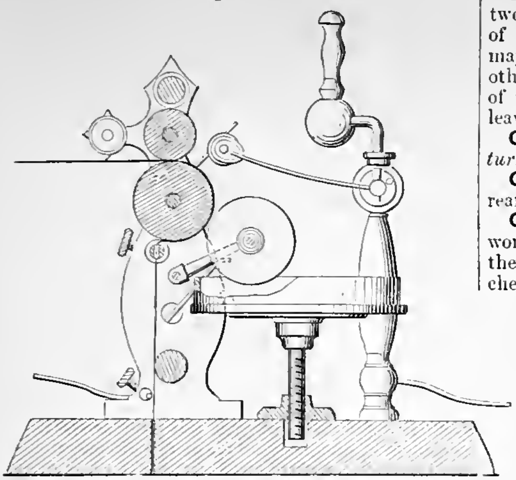
Chem'i-cal Ap'pa-ra'tus. The name *chemistry* indicates literally "Egyptian art," the art of the black land; for Plutarch knew that the Egyptians called their country Χημεία, from the black earth. The inscription on the Rosetta stone has *Chmi*. See Still, Balance, Hydrometer, etc., in their specific alphabetical places.

Chem'i-cal Fur'nace. A small furnace for laboratory uses. See Stoves and Heating Appliances.

Chem'i-cal Print'ing-tel'e-graph. An apparatus for printing symbols upon prepared paper by means of electro-chemical action; as, for instance, by an iron stylus on paper prepared with a solution of yellow cyanide of potassium. In the example, the paper strip, just before passing under the recording-needle, is moistened by contact with a wheel revolving in a reservoir of suitable liquid. See Electro-chemical Telegraph. (Fig. 1266.)

Chem'ick-ing. (*Bleaching.*) The process of steeping goods in a dilute solution of chloride of lime in stone vats, the liquor being continuously pumped up and straining through the goods until the

Fig. 1266.



Chemical Printing-Telegraph.

action is complete. This precedes the *souring* which sets free the chlorine. See BUCKING KIER.

Che-min' des Rondes. (*Fortification.*) A beam at the foot of the exterior slope, sometimes masked.

Che-mise'. 1. (*Masonry.*) A wall that lines the face of a bank. A *breast-wall.*

2. A French name for an under-garment; from the Spanish *camisa,* a shirt; this from the Arabic *kamis,* which is from the Sanscrit *kschauma,* linen. The garment, its name, and the cotton from which it is now made, were introduced into Europe by the Spanish Saracens.

Chem'i-type. (*Engraving.*) A somewhat general term which includes a number of relief processes by which a drawing or impression from an engraved plate is obtained in relief, so as to be printed on an ordinary printing-press.

Cover a zinc plate with *ground,* and etch the design; bite in in; remove the ground; fill the lines with fusible metal, and scrape down to the zinc surface. Bite the plate with aqua-fortis, which will cut away the zinc and leave the fusible metal salient to be printed from by the ordinary press.

Che-nille'. A round fabric or trimming, made by uniting with two or more sets of warps, either by weaving or twisting, a fine filling or weft, which is allowed to project beyond the warps. This filling is cut at its outer edges, and the fabric is then twisted, assuming a cylindrical shape with weft projecting radially from the central line of warps.

Che-nille' Car'pet. The chenille carpet is soft and beautiful, but costly. In making it, the warp-threads are stretched out horizontally, as in a common loom, and the weft is thrown in by a shuttle; but this weft consists of chenille, instead of mere yarn, and when the weaving is completed, the loose, colored threads of the chenille are combed up and made to appear at the surface, where they are cut and sheared to a state of velvety softness. The pattern is dyed in the chenille itself, nothing appearing at the surface of the carpet except the ends of the chenille fringe.

Che-nille'-ma-chine'. In one form of French machine, the material is constantly reflexed upon itself, so that the article in the first instance presents a series of close loops, which must be cut, to give it a finish. Martin's machine, invented in 1851, produces in this way 2½ yards per minute.

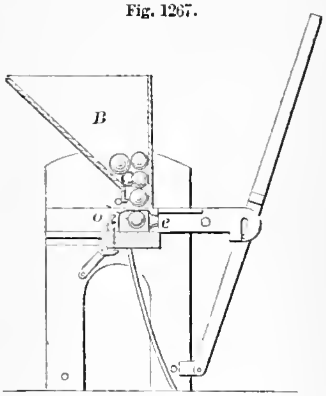
In Canter's machine the silk is confined between two strands, which are twisted together in the act of manufacture, and a rotatory knife is let down as may be required, to cut the pile, or silk, worsted, or other material which forms the ornamental surface of the chenille; or, by holding the knife aloft, to leave the pile uncut, to vary the effect.

Chep. A piece of timber forming the *sole* of a *turn-wrest plow.*

Cher'ry. A spherical bur. Used especially in reaming out the cavities of bullet-molds. See BUR.

Cher'ry-ston'er. A domestic implement which works by introducing a forked prong, which pushes the cherry-stone out of the pulp. In Fig. 1267, the cherries fall from the hopper *B,* and are thence pushed

Fig. 1267.

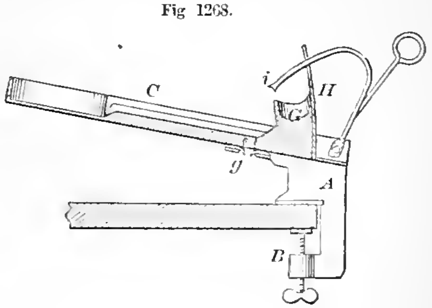


Cherry-Stoner.

in a gang by a plunger provided with a series of faces *c,* separated by plates and acting upon the cherries individually. Each stone is detained by a cruciform plate *o,* whose single post traverses a slot in the annular face of the plunger, which expels the fleshy portion.

In Fig. 1268, the cherries pass from the hopper *C* down inclined chutes to the cavities, where they are consecutively operated upon by the descending forked plungers *i,* which push the stones through the elastic diaphragms *g* and return with the impaled fruit, which is stripped from them by plate *H,* and falls into an inclined discharging-trough *G.* *A B* is the clamp by which the cherry-stoner is attached to the table-leaf.

Fig 1268.



Cherry-Stoner.

Chess. 1. A board-game which originated at an early date in India. The *chaturanga,* or primeval Indian game, was played by four persons, and the piece to be moved was indicated by throwing dice.

This was the game down to the sixth century A. D. From thence to the sixteenth century the mediæval game (the Shatranj) was practiced. In this two persons only played, and the element of chance was discarded.

Modern chess extends from the sixteenth century to the present time, the change from the mediæval consisting in the increase of the power of bishops and queen, and the introduction of castling.

The Emperor Akbar (1543–1605), surnamed Jalal-ud-din, "The Glory of the Faith," had a chess court in his palace at Futtehpore, nineteen miles from Agra on the Ganges. He was the greatest and the wisest of the monarchs of Hindostan, and, like Alfred of the West Saxons, seems to have been as versatile as he was grand. On the tesselated pavement of one of the court-yards of this splendid palace, the prince set his battle in array, with the mimic kings, queens, priests, and men-at-arms; his vizier and he marshaling the forces, and ordering the moves of the living pieces. With pretty girls for pawns, and beardless beings of epicene gender for priests and cavaliers, he probably came as near enjoying himself as any one can who has all he wants.

2. A flooring board of a military bridge. The *chesses* lie upon the *balks*, which are longitudinal timbers resting upon the *bateaux* or *pontons*. *Chessex.*

Ches'sel. The perforated wooden mold or vat in which cheese is pressed. *Chesser.* See CHESS.

Chess-tree. (*Nautical.*) A piece of oak fastened on the top-side of the vessel, for securing the main-tack to, or hauling home the clue of the main-sail.

Chest-bel'lows. The piston bellows.

Chest-lock. A mortise lock, inserted vertically into the body of a chest or box, the plate, which frequently has two staples, being let into the under sides of the lid. The bolt has a horizontal movement.

Chest-rope. (*Nautical.*) A long boat-rope, or warp.

Chest-saw. A species of hand-saw without a back.

Che-val'-de-frise. A bar traversed by rows of pointed stakes, and used to barricade an approach or close a breach. Called a *Friesland horse* because first used at the siege of Groningen, in that province, in 1658.

Che-val'-glass. A looking-glass of such size and so mounted as to exhibit the full figure.

Chev'er-il. Leather of kid-skin.

Che-ville'. The peg of a violin or similar stringed instrument.

Chev-rette'. (*Ordnance.*) A machine for raising heavy guns on to their carriages.

Chev'ron. 1. A bent bar, rafter-shaped, in heraldry, and the form adopted for a distinguishing mark on the coat-sleeves of non-commissioned officers.

2. A zigzag molding.

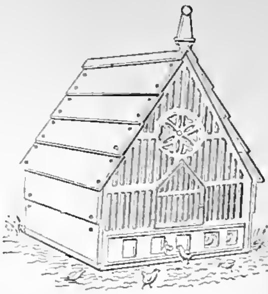
Chi-a'ro-os-cu'ro. 1. A drawing made in two colors, black and white.

2. (*Printing.*) A system of printing by successive blocks of wood which carry respectively the outlines, lighter and darker shades, etc. Practiced in Germany and Italy in the fifteenth and sixteenth centuries.

3. A term used by artists to describe the effect of light and shade in a picture.

Chick'en-coop. A house or inclosure for fowls, of more or less pretensions. In the example the coop is provided with a metallic open-work end-piece, provided with sliding doors connected together so as to be opened simultaneously. The broods are protected by closing these sliding-doors at night.

Fig. 1269.



Chicken-Coop.

Chick'en-rais'ing Ap'pa-ra'tus. An *incubator* (which see).

Child's Car'riage. A small carriage adapted for children's uses, being drawn or pushed by an attendant.

Chil'i-an Mill. From time immemorial the ores of Mexico, Central America, and Peru have been worked, and the processes yet used in some of the more remote districts are rude and wasteful or exceeding slow. The Chilian mill and arrastra are specimens of the latter. *A* in the accompanying cut shows the adaptation of water-power as a motor for the primitive mill of Central America, the arrangements being of a massive and rude description. *B* shows a more modern form of the same device.

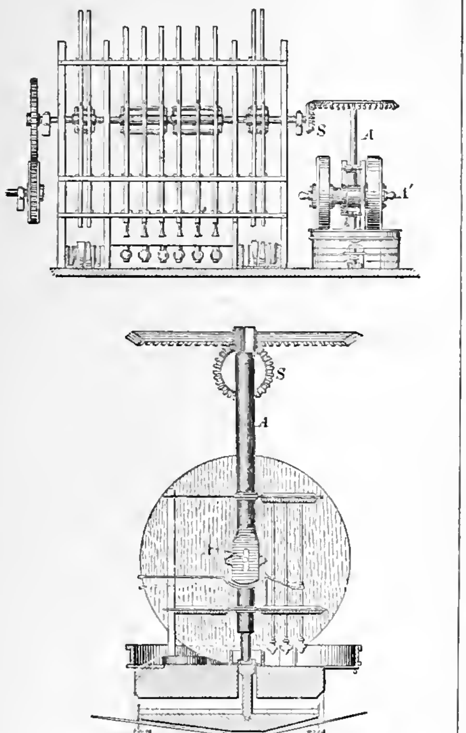
Fig 1270.

Chilian Mill.

The modern form of the Chilian mill in its application to the grinding of oleaginous seeds, nuts, kernels and fruits, is shown in Fig. 1271.

Each stone has a rotation on its horizontal axis *A'*, and also a rotation around the common, vertical axis *A*. The latter is driven by the pinion *S* and bevel cog-wheel. A certain latitude of motion is allowed to the stones on their horizontal axis, and this passes through an oval aperture in the shaft *A*, so as to allow the shaft to rise and fall according to the quantity of material under the stones; the freedom of motion allowing the stone to pass over heaps of the material without straining. The bed-stone is supported on a foundation of masonry, and has raised inner and outer borders to keep the material from falling off. The grain is collected in the paths of the stones by scrapers, which partake of the motion of the central post, one scraper gathering the magma from the outlying parts and placing it in the track of one stone while the other scraper draws it so as to be crushed by the other stone. The stones are placed at different distances from the vertical shaft, so as to give them a wider track of usefulness. The inner one is two thirds of its width

Fig. 1271.



Oil-Mill.

nearer to the shaft, so that their tracks lap a little. When the crushing is completed, another adjustment of the scrapers transforms them into clearers, and they carry outwards the material, which then falls through an open part of the hoop, and is collected in a receptacle whence it is shoveled into bags ready for the press.

The Chilian mill, so called (also known as the "*Trapiche*"), is as old as Herodotus, at least. It was used by the Phœnicians for mashing olives. See OIL-MILL.

Chill. A piece of iron introduced into a mold so as to rapidly cool the surface of molten iron which comes in contact therewith. Cast-iron, like steel, is hardened by rapid cooling, and softened by the prolongation of the cooling process. The extreme in the former direction gives *chilled iron* the hardness of hardened steel; the extreme in the direction of softness is obtained by prolonging the heat, abstracting the carbon from the cast-iron, reducing it to a nearly pure crystalline iron. See MALLEABLE IRON.

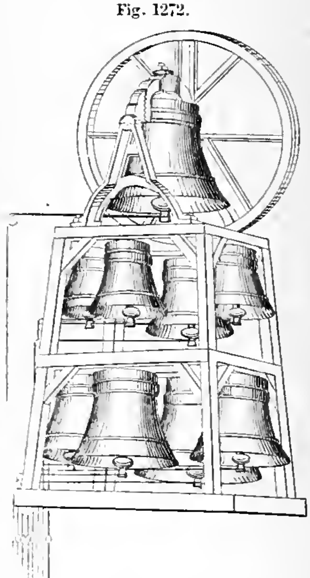
The chilled cast-iron plowshare has a hard undersurface, and the top wears away, leaving a comparatively thin edge of hardened metal. This resembles the natural provision in the teeth of rabbits, squirrels, and other rodents, whereby the enamel remains in advance of the softer portion of the tooth, keeping a sharp edge.

Chilled castings are used for axle-boxes, iron wheel-hubs, rolls for iron-rolling mills, plowshares, and mold-boards, stamp-heads, heavy hammers, and anvils for some kinds of work, and in many other instances.

Chill-hard'en-ing. A mode of tempering steel-cutting instruments, by exposing the red-hot metal to a blast of cold air.

Chime. 1. A number of bells attuned to each other in diatonic succession. A *peal* consists of three or more bells in harmonic succession, which may be rung successively or simultaneously, but will not admit of a tune being played upon them. Thus a set embracing the eight notes of the common scale will constitute a chime, while a set upon the *first*, *third*, *fifth*, and *eighth* of the scale would be a peal. The smallest number of bells that can be said to constitute a chime is five, but the number may be increased indefinitely. The usual number is at least nine, which number embraces the eight notes of the natural scale, with the addition of a flat seventh.

Fig. 1272.

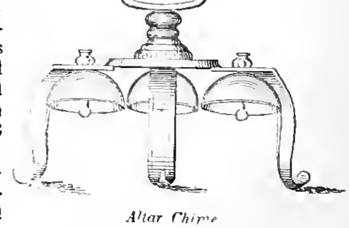


Chime.

The illustration shows a chime in a Philadelphia church; nine bells, key of D, weight 12,798 pounds.

A set of three small bells mounted in a stand for ringing by hand, used in the Roman Catholic church service, is also called a chime, or *altar chime*.

Fig 1273.



Altar Chime.

A new carillon of bells manufactured in France and mounted in Buffalo, is 43 in number. They are worked by a keyboard, and discourse beautiful music. Attached to the carillon, and independent of the key-board, is a clock, which, by delicate machinery, is made to play any arranged tune on the bells by means of 123 hammers adjusted on the outside of the bells. The clock also strikes the hours, half-hours, and quarters.

Apparatus for ringing chimes is said to have been first made at Alost, in the Netherlands, in 1487. Scheppen of Louvain is celebrated as a chime-player, and performed violin music. Potthoff, the chime-player of Amsterdam, 100 years since, played piano-forte music with facility. Each key required a force equal to two pounds' weight.

Chimes on a small scale, rather as toys and scientific instruments, have been rung by electricity; a clapper or suspended ball being made to rotate around a central axis, striking in succession the bells which are arranged in a circle beneath.

2. An arrangement of bells and strikers in an organ or musical box, operated in harmony with the reeds, pipes, or tongues, as the case may be.

3. (*Coopering.*) The rim of a cask or tub, formed by the ends of the staves, which project beyond the head.

Chime-bar'rel. (*Horology.*) A prolongation of the rim of a striking-wheel, which is furnished with pins, like the barrel of a musical box, the pin lifting the tails of the hammers, which are set on one axis and strike their respective bells when set in motion.

Chim'ming. (*Metallurgy.*) The operation of agitating ore in a *keeve* or tub, by means of a stirrer, the *keeve* being inclined at an angle of 45°. The ore and water being placed in the tub, the whole mass is violently stirred until it all partakes of the gyration, when the stirring is stopped and the heavier particles first reach the bottom. The different strata of particles are then sorted according to quality. See KEEVE.

Chim'ney. The open hole for the emission of smoke is referred to in Herodotus, VIII. 137: — "Now it happened that the sun was shining down the chimney into the room where they were; . . . . the boy who had a knife in his hand made a mark with it round the sunshine on the floor of the room."

The passages from the Greek authors, which have been cited as showing the use of chimneys, do not prove their existence, but generally refer to a mere opening at which the smoke escaped.

Here, however, is one fair notice of a chimney: —

"*B.* Don't cut me, cut the meat, —
Boys, bring the kid.
A. Is there a kitchen near?
B. There is
A. And has it got a chimney too?
For this you do not say.
B. It has a chimney.
A. But if it smokes, it will be worse than none.
B. The man will kill me with his endless questions"

From "The Woman sitting up all Night," a play by ALEXIS; quoted by ATHENÆUS in the "Deipnosophists," A. D. 220.

One mode of warming is noticed by Seneca and Pliny, and consisted in an arrangement of pipes to convey hot air from an underground apartment into which red-hot coals were occasionally thrown. The intention was to avoid the smoke incident to the burning of the fuel before it attained the red-hot condition. In the greater number of houses the fuel was burnt in the room and the smoke escaped as it could, at the nearest door, window, or an opening in the roof. In the hot-air arrangement described, the caloric current was conveyed by pipes to the room, and discharged at a mouth which was often ornamented with a dolphin's or a lion's head, according to fancy, and which could be opened or shut at pleasure.

The Emperor Julian, when at Paris, complained of the rigor of the climate and the inefficient means for mitigating it, even in the best apartments. He disliked the braziers, and it would seem that no arrangements, such as described by Seneca, and suggested by the hypocaust of the baths, was at hand. See HYPOCAUST; HEATING APPARATUS.

Vitruvius does not mention chimneys. Winckelmann states that no traces of them are found in Herculaneum, where the people warmed themselves by fires in braziers placed on the floor of the apartment, as did Alexander the Great — according to Plutarch.

In Pompeii, chimneys are seen in connection with bath-rooms and bake-houses, but none in private dwellings.

Palladio only mentions two chimneys, which stood in the middle of the rooms, and consisted of columns, supporting architraves whereon were placed the pyramids or funnels through which the smoke was conveyed. Scamozzi mentions only three in his time, placed similarly.

We learn from Fletcher — "Notes from Nineveh" — that the houses in Mosul, on the Tigris, are not always provided with chimneys, although the weather is occasionally very severe. They use a round brazen vessel, with two rings attached to the sides, by which it is conveyed from one room to another. Mosul is termed by travelers the "Modern Nineveh," and the apartments of the old palace which once stood in the vicinity were no doubt similarly heated. Hosea xiii. 3, speaks of the smoke escaping from the chimney (a hole in the roof), and makes it an emblem of instability.

There are no chimneys or fireplaces in the houses of the Japanese. In the center of the common sitting-room there is a square hole lined with tiles and filled with sand, in which a charcoal fire is kept burning, and a teakettle is supported above by a tripod. A superior class of houses are warmed by braziers placed on lacquered stands. Holes in the roof and walls allow the smoke to escape. Wood, in its natural state, is but little used as fuel.

Travelers tell us that even now in Rome, which has a humid and raw atmosphere at times, the mode of warming is by chafing pans and portable charcoal furnaces, rather than by the generous fire of a grate or furnace.

Down to the thirteenth century, the people seem to have been generally destitute of chimneys. In the Middle Ages people made fires in their house in a hole or pit in the center of the floor, under an opening formed in the roof; and when the family laid down for the night, — for it can hardly be said they went *to bed*, — the hole was closed by a *cover* of wood. The laws of the feudal ages (*couvre-feu* of the French; curfew-bell of the English), ordered that such fires should be extinguished at a certain time in the evening. William I. introduced this law into England in 1068, and fixed the *ignitegium* at seven in the evening. The law was abolished by Henry I. in 1100.

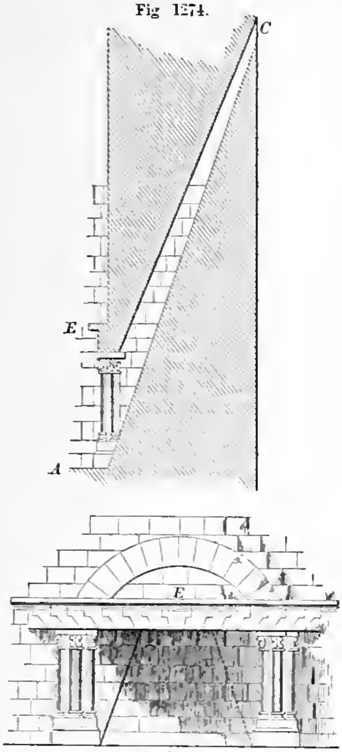
The curfew-bell also answered as a vesper-bell, calling the people to prayers. Pope John XXIII. ordered three *Ave-Marias* to be repeated at the hearing of the ignitegium. Pope Calixtus III. ordered the bell to be rung at noon also, to drive away a dreadful comet and the Turks. In due time the comet left, by which the faith of the people in bells was much strengthened, no doubt. The Turks, under Mahomet II., who had captured Constantinople a few years previously, were, however, long the bane of that corner of Europe, and are yet.

We find distinct notices of chimneys about the middle of the fourteenth century, at Venice, Florence, and Padua.

Francesco de Carraro, lord of Padua, came to Rome in 1368, and finding no chimneys in the inn where he lodged, because at that time fire was kindled in a hole in the middle of the floor, he caused two chimneys, like those which had been long used in Padua, to be constructed and arched by masons and carpenters whom he had brought along with him. Over these chimneys, the first ever seen in Rome, he affixed his arms, which were remaining in the time of Gataro (the narrator), who died of the plague in 1405.

Among the earliest English chimneys of which we have any knowledge is that of the large fire-hearth in the great guard-room of Conisborough

Fig 1274.



Fireplace and Chimney in Conisborough Castle.

Castle, erected in or near the Anglo-Saxon period. The mantel is supported by a wide arch, with two transom stones running under it; the back of the fireplace, where it joins the hearth, is in a line with the walls of the room, and the recess at the mantel is formed by the back of the fireplace sloping outwards, as it rises into the thickness of the wall, until it reaches a loophole on the outside, where the smoke finds an exit. The cut shows an elevation and a section of this fireplace, in which *A* is the floor of the room, *E* the mantel, and *C* the loop-hole.

In other castles erected about the same period, the hearth was formed in the thickness of the wall, and the conical smoke-tunnel ended in a loop-hole, as at Conisborough Castle.

Winwall House, in Norfolk, England, is of the Anglo-Norman period, has recessed hearths and flues rising from them, carried up in the external and internal walls. It was built in the twelfth century. Rochester, Kenilworth, and Conway Castles, Great Britain, show chimneys similar to that in Conisborough Castle.

A chimney in Bolton Castle, erected in the reign of Richard II., 1377–1399, has a chimney thus described by Leland: —

"One thynge I muche notyd in the hawle of Bolton, finiched or kynge Richard the 2 dyed, how chimeneys were conveyed by tunnels made on the syds of the walls betwyxt the lights in the hawle, and by this means, and by no covers, is the smoke of the harthe in the hawle wonder strangely conveyed."

In the old palace at Caen, which was inhabited by the Conqueror while he was Duke of Normandy, the great guard-chamber contains two spacious recessed fire-hearths in the north wall, still in good preservation, from which the smoke was carried away in the same manner as in the above examples.

The opening into the room is the *fireplace*.

The floor of the *fireplace* is the *hearth*.

The paved portion in front of the hearth is the *slab*.

At the back of the fireplace is the *fire-back*.

The flaring sides of the fireplace are the *covings*.

The vertical sides of the opening, a part of the wall of the apartment, are the *jambs*.

The *chimney-piece* is the ornamental dressing around the *jambs* and *mantel*.

The entablature resting on the latter is the *mantel*.

The *mantel-shelf*, or *mantel-piece* rests thereupon.

The whole hollow space from the fireplace to the top of the wall is the *funnel*, or *chimney-hood*.

The contracting portion of the funnel is the *gathering*.

The narrowest part is the *throat*. The throat is closed (at times) by a *damper*.

Above this is the *flue*.

The wall above the mantel against the flue is the *breast*.

The chimney above the roof is the *shaft*.

This, in England, is usually surmounted by a *chimney-pot*. And that frequently by a *hood*, *vane*, or *cowl*.

A cluster of chimneys is a *stack*.

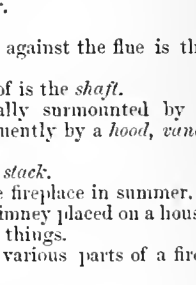
A *chimney-board* closes the fireplace in summer.

A *ciper-tunnel* is a false chimney placed on a house as an ornament or to balance things.

Fig. 1275 illustrates the various parts of a fireplace and chimney.

a, wall.
b, back.
c, breast.
d, flue.
e, hearth.
f, slab.
g, floor.
h, mitered border.
i, brick-trimmer.
j, ceiling.
k, joists.
l, mantel-shelf.
m, reveal or coving.
n, throat.
o, mantel.
p, jamb.
q, plinth.
r, bridging.

Fig. 1275.



Chimney.

The chimney at the Port Dundas Works, Glasgow, is the tallest chimney and one of the highest masonry structures in existence. In Europe there are only two church steeples, those of the Strasburg Cathedral and of St. Stephen's Church, in Vienna, which, by a few feet, exceed the hight of this chimney, and the great Pyramid of Ghizeh was — but is not now — the only other human erection exceeding this great chimney in hight. The dimensions of this chimney are: — Total hight from foundation, 468 feet; hight above ground, 454 feet; outside diameter at the level of ground, 32 feet; outside diameter at the top, 12 feet 8 inches; thickness at ground level, 7 bricks; thickness at the top, 1½ bricks. The internal diameter at the base is 20 feet, and it gradually contracts toward the top to 10 feet 4 inches diameter. The section is circular throughout. The batter is straight, and it has no cap.

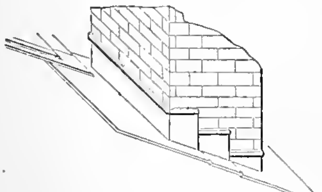
During its erection it underwent the operation of straightening by sawing the mortar joints. The mortar in the newly built portion of the work being still soft and plastic, the pressure of the wind caused a lateral deflection of the column, amounting to 7 feet 9 inches from the vertical at the top. The whole structure was thereby endangered, and in order to restore its stability, it was necessary to bring it back to the vertical line. This was safely accomplished by sawing away the mortar on the bowing side at selected points, so as to cause the chimney to settle back again and resume the perpendicular.

A wrought-iron chimney, 196 feet high and six feet seven inches in diameter, has just been erected in Pittsburg. Another is to be put up 275 feet high. The first was riveted together in a horizontal position, and then lifted to the perpendicular by a crane. The other is made upright, the plates being riveted by means of a scaffolding running up inside.

Chim'ney-cap. An abacus or cornice forming a crowning termination for a chimney.

A device to render more certain the expulsion of smoke, by presenting the exit aperture to leeward, or by a rotatory device. See Cowl.

Fig 1276



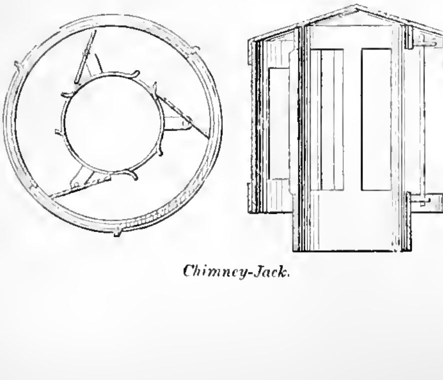
Chimney-Collar.

Chim'ney-col'lar. A device to prevent the leakage of rain around a chimney-stack where it protrudes through a roof. The slates or shingles lie upon the slanting plates, and upright plates lie closely against the bricks.

Chim'ney-hook. A hook suspended in a chimney from which to hang pots over the fire.

Chim'ney-jack. A rotating chimney-head. A form of *cowl*. In the example, the chimney-head has segmental sliding doors, within which are pivoted plates which deflect the currents passing through the side openings of the chimney.

Fig 1277.



Chimney-Jack.

Chim'ney-piece. The ornamental frame round a fireplace; consisting of jambs and mantel.

Chim'ney-pot. A tube of pottery or sheet-metal to extend a flue above the chimney-shaft. They are sometimes ornamental, and made to agree in design with the character of the building.

Fig. 1278.

Chimney-Pot.

Chim'ney-shaft. The part of a chimney above the roof.

Chim'ney-sweep'er. Invented in England by Smart, 1805, to supersede the climbing boys, who were so cruelly treated. A brush of rattan is fixed on the end of a rod which consists of jointed sections of cane, with a rope running down throughout the length of each section.

Chim'ney Top. 1. A chimney-cap or a cowl. See Cowl.

2. (*Music.*) In organ building: a metallic mouth-pipe whose otherwise closed upper end has an open tube of small dimension, which allows a part of the air to escape and has the effect of sharping the note. See Mouth-pipe.

Chim'ney-valve. A device of Dr. Franklin for withdrawing the foul air from an apartment by means of the upward draft in the chimney. In its simplest form it consists merely of a metallic frame fitted in an aperture in the chimney and having a suspended flap opening inwardly to the chimney which allows a current to pass in that direction, but shuts off a down-draft into the room.

Chi'na. A fine variety of pottery, now known as porcelain, originally introduced from the country whose name it bore for some centuries. The term porcelain is Portuguese. See Porcelain.

Chi'na-blue Style. A mode of calico-printing in which indigo-blues are printed on the cloth and fixed by baths of salts of iron and of alkali.

Chi'na-grass Cloth. (*Fabric.*) A fine fabric made from the fiber of an Indian nettle, the *Rheea* or *Ramie*.

Chin-chil'la. (*Fabric.*) A heavy cloth for women's winter cloaking, with a long-napped surface rolled into little tufts in imitation of chinchilla fur.

Cni'né. (*Fabric.*) *a.* A lady's dress goods made with printed or dyed cotton or silk warps, afterwards woven. A mottled effect is produced.

b. A fabric in which a mixture of colors is produced by a double thread formed of two smaller threads of different colors twisted together.

Chine'ing-ma-chine'. (*Coopering.*) A machine to chamfer the ends of staves on the inner surface, and form the chine.

Chi-nese'-bal'ance. A form of the *steelyard* having four points of suspension and as many quadrated sides to the weight-arm of the lever. See Steelyard.

Chi-nese'-cap'stan. A differential hoisting or hauling device, having a vertical axis, and therein only differing from the *differential windlass* (which see).

Chi-nese′-fire. A pyrotechnic composition consisting of gunpowder, 16; niter, 8; charcoal, 3; sulphur, 3; cast-iron borings (small), 10.

Chi-nese′-wind′lass. A differential windlass in which the cord winds off one part of the barrel and on to the other, the amount of absolute lift being governed by the difference in the diameters of the respective portions.

It is a good contrivance in the respect that great power may be attained without making the axle so small as to be too weak for its work. See DIFFERENTIAL WINDLASS.

Chin′ka. The single cable bridge of the East Indies, upon which traverses a seat in the shape of an ox-yoke.

Chinse. (*Nautical.*) To stop a seam temporarily by crowding in oakum with a knife or chisel. A slight calking.

Chins′ing-i′ron. (*Nautical.*) A calker's edge-tool or chisel for chinsing seams.

Chin-strap. (*Saddlery.*) A strap connecting the throat-strap and nose-band of a halter.

Chintz. A cotton cloth gayly printed with designs of flowers, etc., in five or six different colors. It was a favorite in the time of Queen Anne, long before cotton prints became cheap.

> — "let a charming chintz and Brussels lace
> Wrap my cold limbs and shade my lifeless face."

The English Parliament had prohibited the burial of corpses in cotton or linen goods, intending to improve the demand for woolens. The young lady is supposed by Pope to express her disgust at donning the unfashionable fabric even for burial.

Swift says: — "Chintzes are gaudy and engage our eyes."

The name, being highly respectable, has since been applied to goods lacking the graceful and artistic character of the genuine article.

The chintzes of the Coromandel coast were celebrated in the time of Marco Polo, thirteenth century. They are mentioned also by Odoardo Barbosa, a Portuguese, who visited India soon after the passage of the Cape of Good Hope by Vasco da Gama: — "Great quantities of cotton cloths admirably painted, also some white and some striped, held in the highest estimation."

Chip. (*Nautical.*) A piece of wood of the shape of a quadrant, of 6 inches radius, and ¼ inch thick, placed on the end of a log-line. The chip is loaded at the circular edge so as to float upright, about two thirds being immersed in water. The knotted log-line is wound on a reel, and the *chip* or *log* being thrown overboard catches in the water and remains about stationary there, while the cord unwinds as the vessel proceeds. The number of knots passing the seaman's hand while the sand in the half-minute glass is running out, indicates the number of knots or nautical miles per hour of the vessel's speed. See LOG.

Chip-ax. A small, single-handed ax used in chipping or listing a block or scantling to a shape approximating that to which it is to be dressed.

Chip′ping-chis′el. A cold chisel with a slightly convex face and an angle of about 80°; used in removing a scale of iron, hardened by contact with the damp mold in casting. The removal is a preparation for finishing with the file or other tool, the chilled iron being very destructive of files.

Chip′ping-ma-chine′. A planing-machine for cutting dye-woods into chips. See BARK-CUTTING MACHINE.

Chip′ping-piece. (*Founding.*) *a.* An elevated cast (or forged) surface, affording surplus metal for reduction by the tools.

b. The projecting piece of iron cast on the face of a piece of iron-framing, where it is intended to be fitted against another.

Chi′ra-gon. A writing-machine for the blind. A *cecograph.*

Chi′ro-plast. An instrument, or *hand-director*, as its name indicates, for training and exercising the hands, for giving them facility and command in playing music. It was invented by Professor John Bernard Logier, a native of Germany, and resident of London, England, who died about 1852. Patented in England about 1812.

It consists of the *position-frame*, to keep the hands from wandering; the *finger-guides*, two movable brass frames each having five divisions; and the *wrist-guide*, to preserve the proper position of the wrist.

The *gamut-board* was also a portion of the apparatus, its use being to indicate the notes, it being fitted closely to the finger-board.

The inventor was a distinguished contrapuntist and theorist, — a musical luminary.

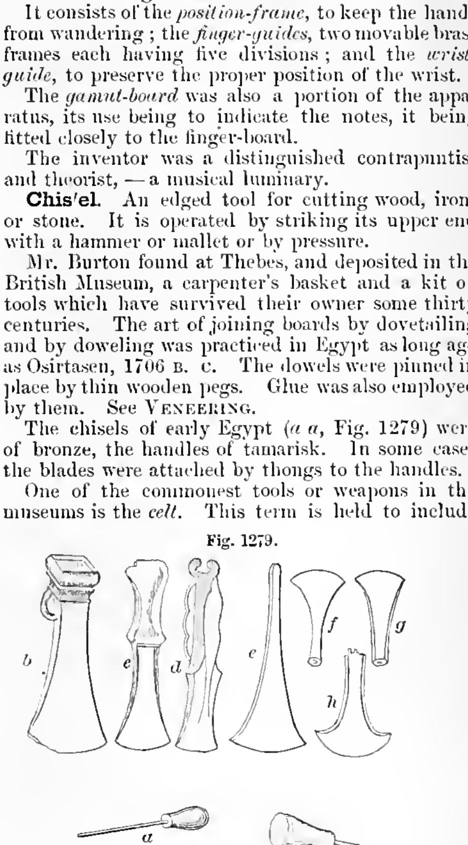
Chis′el. An edged tool for cutting wood, iron, or stone. It is operated by striking its upper end with a hammer or mallet or by pressure.

Mr. Burton found at Thebes, and deposited in the British Museum, a carpenter's basket and a kit of tools which have survived their owner some thirty centuries. The art of joining boards by dovetailing and by doweling was practiced in Egypt as long ago as Osirtasen, 1706 B. C. The dowels were pinned in place by thin wooden pegs. Glue was also employed by them. See VENEERING.

The chisels of early Egypt (*a a*, Fig. 1279) were of bronze, the handles of tamarisk. In some cases the blades were attached by thongs to the handles.

One of the commonest tools or weapons in the museums is the *celt*. This term is held to include

Fig. 1279.



Egyptian and Roman Tools.

numerous cutting-tools; it is derived from the word *celtes*, an old Latin term for a *chisel*. Axes, hatchets, chisels, skin-scrapers, and other tools are assembled in these collections under the one name.

In the accompanying cut, *b* is a bronze socket-chisel, 6 inches long, found at Karnbré, Cornwall, England. The ear or loop may have been for carrying it suspended from the girdle, but was probably for lashing it to a helve. See HATCHET, Figs. *e c*.

c and *d* are bronze chisels in the British Museum.

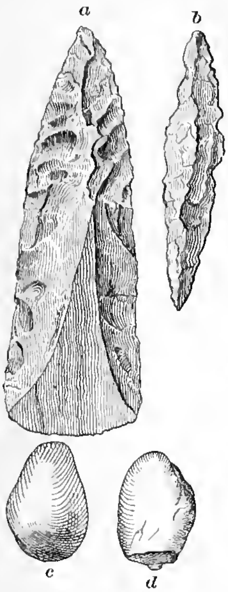
e has a round handle. It is 9 inches long, is of bronze, weighs 2 pounds 5 ounces.

f, *g*, and *h* are smaller tools, adapted to be used with the mallet or otherwise.

The chisels and gouges of the Tahitians when first discovered were of bone, generally that of a man's arm between the wrist and elbow. The bone tools disappeared in a few years after the advent of the white man.

Stone chisels, pointed and wide bitted, also mallets of the modern form, are shown in the paintings of ancient Thebes. They were probably of hard bronze, though it is not to be doubted but that steel was known to the artificers of that wonderful nation. Iron and steel have perished with rust while bronze has survived, and articles of that metal abound in all the museums.

Fig. 1280.



Ancient Flint-Chisels and Sharpening Implements.

The Japanese chisels are light and small. The cutting parts of some are the size and shape of a section of half a dollar, the square side being the cutting edge, and a round metallic shaft connecting the convex side with a wooden handle.

The knife must be regarded as the primary tool, and the chisel is a strong knife sharpened and presented endways.

Holtzapffel, in generalizing on the subject, regards the chisel as a keen wedge, sometimes employed with quiet pressure, and at other times with percussion, the former including the plane bit, and the latter the ax and adze.

The chisel used as a turning-tool introduced the circulatory process, and the reversal of conditions constitutes the cutting-tool the mover and introduces the boring-tool.

Saws he regards as a multiplication of scraping-chisels, and the file as a suggestion from the saw.

The blades of shears and scissors act as chisels from opposite sides of the material, and the punch is a chisel with a circular edge, whose counterpart, if it have one, is an aperture whose margin answers as the opposing shear.

This is ingenious and somewhat satisfactory, and is to be expected of a man who makes the lathe and its cutting-tools the primary central cluster of the mechanical firmament. "It is good to be zealously affected in a good thing," said an able mechanic of yore.

James Watt, no mean judge, said that "the true inventor of the *crank rotative motion* was the man — who unfortunately has not been deified — who first invented the common foot-lathe."

See under the following heads: —

Astragal tool.
Bent gouge.
Blacksmith's chisel.
Blind-slat chisel.
Boasting-chisel.
Bolt-chisel.
Bone-chisel.
Bur-chisel.
Calking-chisel.
Cant-chisel.
Carpenter's chisel.
Carving-chisel.
Center-chisel.
Chasing-chisel.
Chipping-chisel.
Chisel in marteline.
Cold chisel.
Cope-chisel.
Corner-chisel.
Cross-cutting chisel.
Cross-mouth chisel.
Dental chisel.
Diamond-point chisel.
Dog-leg chisel.
Double-chisel.
Drove-chisel.
Entering-chisel.
File-chisel.
Firmer-chisel.
Flat-chisel.
Flogging-chisel.
Framing-chisel.
Gouge.
Grafting-chisel.
Hardy.
Heading-chisel.
Hooked tool.
Ice-chisel.
Indented chisel.
Joiner's chisel.
Making-iron.
Marteline-chisel.
Mortise-lock chisel.
Mortising-chisel.
Paring-chisel.
Parting-tool.
Point.
Pruning-chisel.
Rod-chisel.
Round chisel.
Round-nose chisel.
Sash-chisel.
S-chisel.
Skew-chisel.
Slick.
Small chisel.
Socket-chisel.
Splitting-chisel.
Spoon-chisel.
Tang-chisel.
Tapping-gouge.
Tenoning-chisel.
Tongued-chisel.
Turning-chisel.

Besides those mentioned in the list are several varieties peculiarly adapted to the needs of certain trades; such as: —

Blunt chisels.
Coachmaker's chisels.
Long-paring chisels.
Millwright's chisels.
Mortise-lock chisels.

Chis'el-draft. (*Masonry.*) In squaring the end of a stone block, one edge is chisel-dressed to a straight edge and forms a base for the determination of the other sides.

Chis'el in Mar'tel-ine. A *boasting-chisel* used by marble-workers. It is furnished with steel points at the end. See MARTELINE.

Chit. A small *frow* used in cleaving laths.

Chi-tar'ah. (*Fabric.*) A cotton and silk stuff made in Turkey.

Chlo'ri-na'tion. A process for the extraction of gold by exposure of the auriferous material to chlorine gas.

The process was first introduced by Plattner, a professor in the School of Mines, Freiberg, Saxony.

"The principle involved is the transformation of metallic gold, by means of chlorine gas, into soluble chloride of gold (the *aurum potabile* of the ancients), which can be dissolved in cold water, and precipitated in the metallic state by sulphate of iron, or as sulphide of gold by sulphureted hydrogen gas. The precipitate may then be filtered, dried, and melted with suitable fluxes to obtain a regulus of malleable gold." — RAYMOND.

The following conditions are necessary: —

1. The gold must be in a metallic state.

2. There must be no other substance in the charge which would combine with free chlorine.

3. The chlorine must have no impurities which would dissolve other metals or bases.

4. No reaction must be induced which would cause precipitation of the gold before the termination of the process.

The process with quartz and free gold does not involve roasting, but the latter process is necessary with ores containing sulphurets and arseniurets. In the chlorination process, the ore is sifted into a wooden vat lined with pitch, and having a false bottom beneath which the gas is admitted. The top is luted on and the gas admitted; when the gas begins to escape at a hole of observation in the lid, it is the signal that the air is ejected and the hole is then closed. The gas is continually passed into the mass for say eighteen hours, according to the coarseness of the gold; the cover is removed and water introduced, and the solution drawn off into the precipitation vat. The gold is precipitated by sulphate of iron, the supernatant liquor decanted. The sediment is a brown powder which is filtered upon paper dried in an iron or porcelain vessel, smelted to a metallic regulus in clay crucibles, a little borax, salt, and nitrate of potash being used as fluxes. See Raymond's "Mines, Mills, and Furnaces," pp. 417-431.

Chlo-rom'e-ter. An instrument for testing the decolorizing or bleaching powers of samples of chloride of lime.

Ure's process consists in adding liquor of ammonia of a known strength, tinged with litmus, to a solution of a given weight of the chloride under examination until the whole of the chlorine is neutralized, which is known by the color being destroyed. From the quantity of ammonia consumed the strength of the sample is estimated.

The instrument is an inverted and graduated siphon-shaped tube with a closed long end, and a shorter open end. The tube being filled with mercury, a certain quantity is displaced by a wooden plug, say 10°. This space is filled with the solution of the chloride, which is then let up into the closed end of the tube by putting the finger over the open end and tipping the tube. Liquor of ammonia is now let up, and nitrogen is evolved equivalent to the chlorine present.

Chock. 1. (*Shipbuilding.*) *a.* A block, preferably wedge-shaped, driven behind the props of a cradle to prevent it from slipping on the ways before the ship is ready to launch.

b. A piece of timber, framed into the heads and heels of ship's timbers at their junctions to act as a lap to the joint, and make up the deficiency at the inner angle, as in the stem-piece and the main-piece of the head; in the dead wood, etc. See STEM.

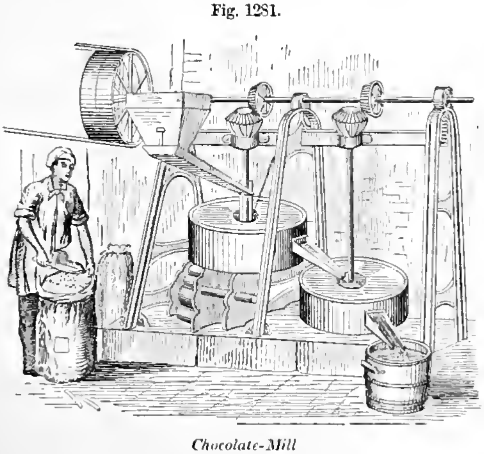
2. A wedge-shaped block placed beneath and against the bilge of a cask to keep the latter from rolling.

3. A piece of wood by which the wheel of a carriage is prevented from moving forward or backward.

In the United States Ordnance Department two kinds are employed, the simplest form being triangular in section, while another description of chock is wedge-shaped and provided with a handle.

Choc'o-late-mill. Chocolate is a paste made from the roasted kernels of the *Theobroma cacao* (food for the gods), so called by Linnæus, who so much esteemed it. The beverage was advertised in London in 1657, as "an excellent West India drink called 'chocolate.'"

Fig. 1281.



Chocolate-Mill

The roasted and crushed seeds of the cacao-nut tree are ground between two horizontal millstones, which are kept at a temperature of about 200° F., by means of a steam-jacket.

The nibs pass down from the hopper into the shoe, which is shaken by a damsel on the spindle of the runner so as to discharge the nibs into the eye which leads them to the space between the stones. The heat and friction liberates the oil, which is one third of the weight, and the cacao issues as a paste from the spout and is conducted to a second and similar mill where the stones are similarly heated but are closer set, so as to still farther reduce the paste. It is discharged from the second grinding in a liquid condition and is collected in a pan, where it hardens into a cake.

To enable it to form an emulsion with water, it receives additional substances. Sugar, honey, molasses, gum, starch, flour, rice, and arrow-root are adapted for this purpose. Spices and flavoring extracts are added for some markets.

Devinck's machine (English) is for wrapping chocolate in paper envelopes.

Choir-or'gan. (*Music.*) One of the three aggregated organs which are combined in an organ of large power. The other two are the *great*-organ and the *swell*. The great organ has its large pipes in front and its bank of keys occupies the middle position; it contains the most important and powerful stops. The *choir*-organ has its key-board below that of the *great*-organ, and contains stops of a light character and solo stops. The *swell* has its bank of keys the highest of the three, and has louvre boards which may be opened and shut by means of a pedal, so as to produce *crescendo* and *diminuendo* effects.

Choke-strap. (*Saddlery.*) A strap passing from the lower portion of the collar to the belly-band, to keep the collar in place when descending a hill or backing.

Chon-drom'e-ter. A steelyard for weighing grain.

Chon'dro-tome. (*Surgical.*) A knife specifically adapted to dividing cartilages.

Chop. The movable wooden vise-jaw of a carpenter's or cabinet-maker's bench.

Chop-boat. A Chinese lighter for transporting merchandise to and from vessels.

Chop-ham'mer. (*Metal.*) A cutting-hammer.

Chop'ness. A kind of spade (English).

Chop'per. An agricultural implement for thinning out plants in drills. It is used in England for turnips; in the United States, for cotton-plants. Cotton-seed is drilled in and comes up in a row; the cotton-chopper straddles the row and *chops* wide gaps, leaving the plants in hills. These are thinned out by hand.

Chop'ping-knife. A knife designed for chopping meat, vegetables, fruit, etc., upon a board, block, or in a bowl. Used on a domestic scale for cutting meat for mince, hash, sausage, etc. See SAUSAGE-MACHINE.

Chorl. The angle at the junction of the blade of a penknife with the square shank which forms the joint.

Cho-rob'a-te. The Greek level. See LEVEL.

Cho'ro-graph. An instrument contrived by Professor Wallace, of Edinburgh. "To determine the position of a station, having given the three angles made by it to three other stations in the same plane whose positions are known."

The problem occurs frequently in maritime surveying, and is otherwise stated : —

"To construct two similar triangles on two given straight lines."

Chro-mat'ic Print'ing. The precursor of color-printing was the illuminated missal with its initial letters and borders, hand-painted in colors, and the playing-cards upon which the art of printing was first executed in Europe. See CARD.

Koster's *Speculum Humanæ Salvationes*, printed at Haarlem, 1440, has engravings on wood printed in different color from the body of the work.

Fust and Sheffer's Psalter, 1457, had initial letters and flourished lines printed in two colors, red and blue.

The art soon became common, and towards the end of the fifteenth century imitations of pen-and-ink sketches on a colored ground were made by celebrated artists. This was followed by drawings on blocks in regular sets for separate colors. Albert Durer engraved such blocks; Parmigiano, Titian, and Raffaelle made designs on blocks for the purpose.

Jackson started a paper-hanging factory at Chelsea, England, 1720 – 1754, the designs being printed in oil by wooden blocks. He appears to have been unsuccessful in some details and in the speculation.

The art was adopted and improved by a succession of persons in England and elsewhere; Skippe and Savage of the former, and Gubitz of Berlin, adding considerably to the eminence already attained.

Savage ground the various pigments of the painter into inks, and imitated water-color drawing successfully.

Whiting and Branston applied different colored inks to ornamental borders, and to notes, bonds, checks, etc., to prevent forgery.

Vizitelly and Branston, and subsequently Baxter, attained considerable excellence. See CHROMO-LITHOGRAPHY.

The invention patented some years ago by Mr. Charles Knight, of London, is a process whereby fac-similes of designs in four colors are produced on the same sheet before it leaves the press, by means of a revolving carriage or bed, upon which the blocks are secured. A mode of printing in four colors by means of turning the tympan with the sheet secured on it was somewhat less complicated than Mr. Knight's. The processes, however, necessitated the application of the four colored inks at every revolution and impression, and also involved considerable outlay for machinery.

In Carpenter's process everything is carried on in as straightforward a manner as in ordinary black printing. It may be thus briefly described : —

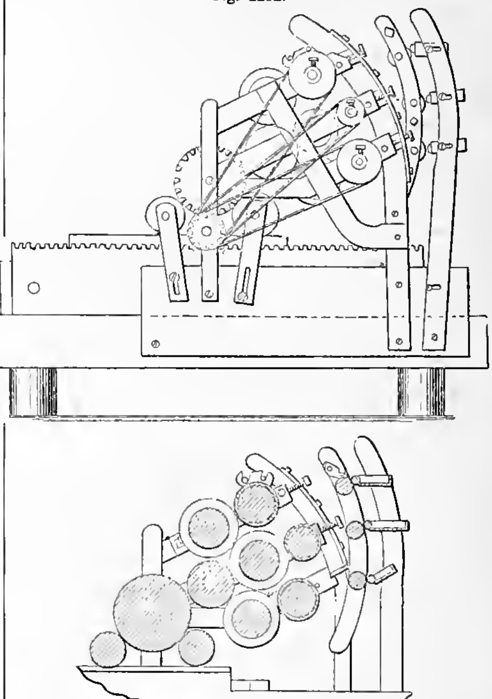
A form is set up by the compositor; he then divides it into four sections, and so imposes them in one chase that the same relative corner of each (whichever may be chosen) shall point towards the middle of the chase. It is then ready for the pressman. It requires *making ready* with points placed, according to the tact of the workman, in such position as may be deemed expedient, four points being sufficient in all, and these so placed that the sheet may be *pointed* when turned either to the right or the left hand. Should 1,000 copies be required, the 250 sheets are printed in the first color. They are then simply turned one quarter round in either direction and printed in the second color. The operation is repeated for the third color, and again for the fourth color. This produces 1,000 perfect impressions of four varieties, in which the colors are differently arranged.

Should the whole possible number of combinations of four colors — namely, twenty-four — be required, nothing more is necessary than, while the sheets are being worked in the second color, to turn a portion of their number into the third and fourth positions, — which produces three kinds of sheets or twelve single varieties, — and while working the third color take half of each of the three kinds and work them respectively in the second, third, and fourth positions, producing six kinds of sheets or twenty-four single varieties.

One inking apparatus is sufficient, and but one ink is spread at a time, passing over all of the forms at once. This has no artistic merit, unless mere blocks of color in given juxtaposition give opportunity for the exertion of taste in harmony or agreeable contrasts. It is not very different from printing in colored bands or lines of type of different colors.

One press prints in several colors from one form and at one impression by making the inking cylin-

Fig. 1282.



Chromatic Printing-Press.

der in parts and supplying the sections with the separate colors.

Adams, 1844, had a poly-chromatic press by which a number of colors were had at one impression by a series of separate inking fountains.

M'Kenzie, 1846; a series of sliding tympans and corresponding series of plates for the separate colors, which impressed the paper in succession, giving a varicolored result.

Weaver, 1851; an ink trough with perforated side and movable partitions, to give out inks of varying colors in lines or belts corresponding to the lines of type.

Babcock, 1854; a sheet carried on a revolving-platen to plates of successive colors.

Sweet, 1855; narrow distributing rollers carrying various inks and laying them in belts on the inking-roller.

Baker and Hill, 1863; a continuous sheet of paper is printed in two colors, by intermittent motion and successive exposure to two reciprocating platens carrying forms which receive their specific colors from their own set of inking-rollers.

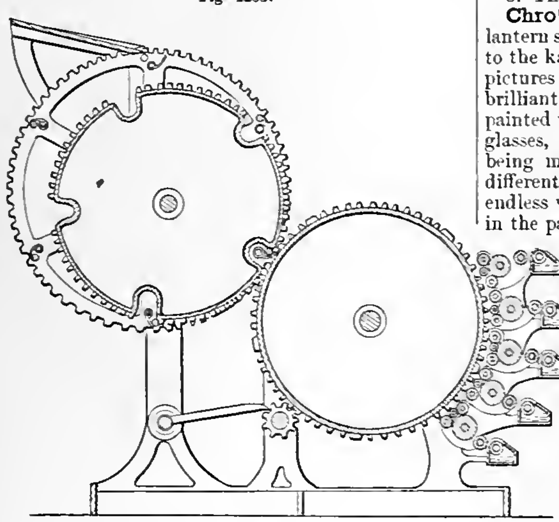
In Baylies and Wood, 1867, an oscillating frame carries a series of rollers which are brought in contact with fountain rollers of a series of fountains, each carrying different colored ink; and the ink is communicated by another series of rollers to the segmental rollers, which in turn communicate the ink to a set of rollers common to all, and by which the type is inked in strips of various colors.

Slater, 1868; adjustable parallel inking-tables, each carrying its own color and furnishing it to a belt of corresponding width on the inking-roller.

Hunt, 1868; two forms, two impressions, ink-rollers with bands of colors.

In Dunk's press the sheet is held by the nippers while it receives the colors consecutively. There are two sectional cylinders revolving in unison, one of them carrying the required number of forms and the other a corresponding number of tympans, while a skeleton cylinder contains the nippers. The sheet is retained until fully printed, in the same nippers, which present it to the successive forms, from each of which it receives an impression in a different color.

Fig. 1283.



Chromatic Printing-Press.

The nipper shafts are journaled in wheels of larger diameter than the platen-cylinder, and the series of nippers outnumber the platen surfaces. The platen-cylinder has longitudinal recesses in its periphery, into which the nipper-shafts enter when in proximity to the form-cylinder, and by the larger diameter of the nipper-wheels the sheets are carried to a fresh surface at each revolution to receive the portion put on in fresh color. The inking-rollers are moved radially, to bring them to their proper type and to avoid the forms carrying another color, by cam-grooves which give the necessary motion to their journal-frames. The distributors have their reciprocation by the obliquity of their motive-wheel.

A valuable article on the colors and mixing of colors for chromatic printing may be found in Ringwalt's "Encyclopædia of Printing," pp. 109–112.

Printing in colors by a succession of colors superimposed as to those portions which are formed by the blending of tints is now done by the lithographic process. See CHROMO-LITHOGRAPHY.

Chro-mat'ic Ther-mom'e-ter. When the edge of a rectangular plate of glass is applied to a piece of heated metal, or other substance having a temperature different from that of the glass, and exposed to a beam of polarized light, colored fringes are developed. As the different tints depend on the different temperatures of the glass (which is supposed to be known), and that of the object to which it is applied, the color of the central fringe affords a means of inferring approximately the temperature of the substance. BRANDE.

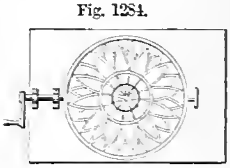
Chro-mat'ic Type. Type made in parts, which are inked of various colors and separately impressed, so as to unite into a variegated whole.

Chro'ma-scope. An instrument to exhibit the three optical effects of colors: —

1. The refraction of prisms and lenses.
2. The transmission of light through transparent media.
3. The reflection of speculums.

Chro'ma-trope. An arrangement in a magic-lantern similar in its effect to the kaleidoscope. The pictures are produced by brilliant designs being painted upon two circular glasses, and the glasses being made to rotate in different directions. An endless variety of changes in the pattern are caused by turning the wheel, sometimes slowly, then quickly, backward and forward.

Fig. 1284.



Chromatrope

Chro'ma-type. (*Photography.*) A process in which the chromic acid is deoxidized. There are several modes of getting photographs by the chromine salts preferably the bichromate of potash.

Chro-meid'o-scope. The same as DEBUSCOPE (which see).

Chro'mi-om'e-ter. An instrument for determining the purity of water by its colorlessness. It consists of a glass tube of about a yard in length, closed at the end by a cork, and resting upon a white dish of porcelain. A green tinge is produced by minute algæ, a white opacity often by fungoid growths; iron salts are indicated by a peculiar ochry color.

Chro'mi-um. Equivalent, 26.4; symbol, *Cr.*; specific gravity, 6.81; is infusible except with an oxy.-hyd. blow-pipe. A grayish-white, brittle, hard metal, and combined with iron makes an alloy which resists all tools of steel, and is used for safes.

Compounds of chromium make beautiful pigments, and afford colors for glass, porcelain, and enamels.

Chro'mo. A contraction of chromo-lithrograph adopted by Mr. Prang, of Boston, for reasons of brevity and as a trade-mark to indicate his productions. See CHROMO-LITHOGRAPHY.

Chro'mo-li-thog'ra-phy. The art of *color-stone drawing* as indicated by the three Greek words from which the name is derived. Color-printing was first applied in Europe to illuminating missals and printing playing-cards. (See CHROMATIC PRINTING.) The printing in a number of colors on wooden blocks or metallic plates was never successful in an artistic point of view, inasmuch as the gradations of light and shade can only be expressed by lines of different thickness and by isolated dots, and do not admit of the complete blending of tints necessary to imitate the effect of an oil-painting. This was accomplished when the art of lithography was brought in aid. Baxter, 1803–1861, in England, produced some really pretty work by a combination of metallic plates and wooden blocks.

Lithography was invented by Alois Senefelder, who was born at Prague, 1771. (See LITHOGRAPHY.) In short, it may be described as drawing upon stone with a material which, when treated with certain chemicals, will take up the printer's ink when rolled up. Senefelder, even at that early date in the history of the art, spoke of the possibility of making fac-similes of oil-paintings. Storch and Kramer, of Berlin, successfully reproduced oil-paintings by this process (1840–1850).

In making chromo-lithographs, an outline drawing is made by tracing, and this is transferred to all the stones (one for each color), required to complete the picture; so as to secure exactness in the corelation of all parts on each stone. Within these outlines, and upon these different stones, the artist draws the different tints and colors. The number of stones, or plates, needed to complete the chromo, varies of course with the character of the picture to be reproduced. The highest number of stones, each representing one tint or color, employed by Prang upon the famous chromo called "Family Scene in Pompeii," was 43. An artist must have not only a high degree of skill in drawing, but must possess a fine feeling for and a thorough knowledge of color, and when a picture is presented to him he must be able to tell, approximately at least, what number of plates will be required to reproduce it, and in what order the tints and colors must follow each other. Furthermore, when drawing a new stone for a chromo in process of printing, he must not only be able to calculate what effect the tint or color in which the plate is to be printed will have upon the preceding tints or colors, — which latter will partly, or perhaps wholly, underlie the new color, — but he must also keep in view the tints and colors still to be added, which again in their turn will tend to modify or alter all those already printed. Thus it will be seen that the accusation sometimes leveled against chromos — viz., that they are merely *mechanical* productions — is wholly unfounded.

To treat it more in detail, it may be said that the drawing is made upon the slab with a sort of colored soap, which adheres to the stone and enters into a chemical combination with it after the application of certain acids and gum. When the drawing is complete, the slab is put on the press, and carefully dampened with a sponge. The oil color is then applied with a leathern roller. The parts of the slab which contain no drawing, being wet, resist the ink; while the drawing itself, being oily, repels the water, but retains the color applied.

In chromo, the first proof is a light ground-tint, covering nearly all the surface. It has only a faint, shadowy resemblance to the completed picture. It is in fact rather a shadow than an outline. The next proof, from the second stone, contains all the shades of another color. This process is repeated again and again; frequently, as often as thirty times. The number of impressions, however, does not necessarily indicate the number of colors in a painting, because the colors and tints are greatly multiplied by combinations created in the process of printing one over another. In twenty-five impressions, it is sometimes necessary and possible to produce a hundred distinct shades.

The last impression is made by an engraved stone, which produces a resemblance to canvas. On proper registering, the entire possibility of producing a picture at every stage of its progress depends. "Registering" is that part of a pressman's work which consists in so arranging the paper in the press, that it shall receive the impression on exactly the same spot of every sheet.

Chro'mo-type. 1. A sheet printed in colors. The modes are various, but the usual plan is to prepare a block for each color, or a form for each color, and to place the paper upon each in succession, the exact place being preserved at each impression by means of register pins or a similar device. See CHROMATIC PRINTING; CHROMO-LITHOGRAPHY.

2. A photographic picture produced in the natural colors. This was long sought by Niepce de St. Victor, and he announced his success even with yellow, but no way has been discovered of fixing these heliochromic pictures.

Chro'mo-scy'lo-graph. A colored picture produced by a succession of wooden blocks, each bearing its separate color. See CHROMATIC PRINTING.

Chro'no-graph. A time indicator.

Astronomical intervals are noted by pressing a key which makes one dot or puncture on a traveling strip of paper and another at the end of the observation. Such a time-paper becomes a record.

The racer's chronograph is one which deposits ink-spots on a traveling paper at the start and arrival of the horses.

Professor Glaesner, of the University of Liége, has a chronograph for the measurement of very minute particles of time by the application of electro-magnetism. To measure the velocity of a cannon-ball, a series of targets, consisting of hoops intersected by wires, are placed at given distances apart. The wires of each hoop communicate with a separate electro-magnetic apparatus, by which an iron pencil-holder is kept in an unvarying position by attraction so long as the circuit is not interrupted. Opposite and close to this pencil-holder there is a cylinder turning on its axis at the rate of four revolutions in a second. Its surface, which is covered with paper, is divided into five hundred parts by lines drawn parallel to its axis, so that each part represents one two-thousandth of a second. Its motion is effected by clock-work. Now, whenever the electric current is interrupted, the pencil-holder ceases to be attracted, and falls on the surface of the cylinder, on which its pencil, therefore, describes a line. Whenever the circuit is completed the pencil-holder is reattracted and leaves the paper. Let us now suppose a cannon-ball to be fired through all these targets, so placed, of course, as to lie in the path of the curve described by the missile. Each time it passes through one of the hoops it snaps asunder one of the wires; the circuit is consequently interrupted, the pencil-holder falls and marks the precise time of the passage. And so on, from target to target, each of which, as we have said, is connected with a separate apparatus. In this way both the space and the time employed in going over it being determined, the velocity, which is the ratio of time to space, is determined also to a fraction of one two-thousandth of a second.

Since 1848, the idea of recording astronomical observations by galvanic electricity has been put in successful operation by several individuals; Professor Hilgard of the coast survey, and Professor Hough of the Dudley Observatory, among the number. The chronograph of the latter prints with type the time of an observation. The professor thus describes it in brief. The plan is based upon the principle of using separate systems of mechanism for the fast moving type-wheel, and those recording the integer minutes and seconds, regulating each with electro-magnets controlled by the standard clock.

I. A system of clock-work carrying a type-wheel with fifty numbers on its rim, revolving once every second; one, two, or parts of two numbers being always printed, so that hundredths of seconds may be indicated. This train is primarily regulated to move uniformly by the Frauenhofer friction balls, and secondarily by an electro-magnet acting on the fast moving type-wheel, and controlled by the standard clock. This train is entirely independent, and can be stopped at pleasure, without interfering with the other type-wheels.

II. A system of clock-work consisting of two or more shafts, carrying the type-wheels indicating the minutes and seconds. The motion of this train is also governed by an electro-magnet, controlled by the standard clock, operating an escapement, in a manner analogous to the action of an ordinary clock; every motion of the escapement advancing the type one number. There are three type-wheels, indicating minutes, seconds, and hundredths of seconds. The integer seconds are advanced at every oscillation of the standard pendulum, and the minute, at the end of each complete revolution of the seconds wheel. The type-wheels are constructed of brass disks, around the circumference of which is soldered a strip of electrotype copper, holding sixty numbers.

The record is made by an armature hammer, the hammer being raised by weight and gear. The types are inked by small rollers. The paper fillet, two inches in width, is wound on a small spool, holding about forty feet, and drawn between two rollers, the same as a Morse register. Every time the hammer falls, the fillet is advanced about one quarter of an inch, by the action of an escapement driven by a weight. One spool of paper will hold about 1,200 observations, including the spacing for different objects. This same escapement is also operated by an electro-magnet, under the control of the observer, who, by pressing a key, is able to make spaces of any width between the prints.

The train carrying the minutes and integer seconds will run eight hours; the gear for elevating the hammer will deliver 800 blows; and the train for moving the paper fillet will go 1,200 times without winding. The fast moving train runs one hour and thirty-six minutes; but since this train can be stopped at pleasure, without changing the zero of the type, its comparatively brief running is not a serious inconvenience.

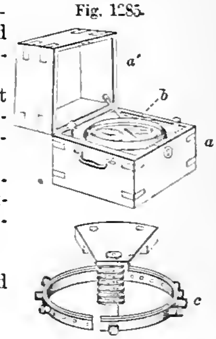
Chro-nom'e-ter. 1. A chronometer is a measurer of time, and this general meaning would include clocks, watches of all kinds, clepsydras, and some other devices, such as hour-glasses and the graduated candles of the beloved King Alfred. The term is, however, applied in a restricted sense to those having adjustments and compensations for the fluctuations of temperature. These have been adapted to the clock and to the watch: in the former the mercurial pendulum of Graham and the gridiron pendulum of Harrison may be cited; and in the latter, the expanding and contracting balance-wheel, depending upon the unequal expansion under changes of temperature of two different metals. With the improvements as adapted to instruments having a balance-wheel this article has to do.

The proposition to determine longitude at sea by means of a timepiece and observation for noon was made by Gemma Frisius, in 1530. The attempt did not fail for want of suggestions; Alonzo de Santa Cruz suggested to determine it by the variation of the compass-needle, and by sand-and-water timepieces, wheel-work moved by weights, and by "wicks saturated with oil," which were supposed to burn equal lengths in given periods of time.

During the sixteenth and seventeenth centuries the Spanish, Dutch, French, and English governments had offered rewards for an instrument which should determine longitude within a certain specified degree of accuracy. Sir Isaac Newton suggested the discovery of the longitude by the dial of an accurate time-keeper, and the Parliament of Queen Anne in 1714 passed an act granting £10,000 if the method discovered the longitude to a degree of sixty geographical miles, £15,000 if to forty miles, £20,000 if to thirty miles, to be determined by a voyage from England to some port in America.

John Harrison, born in 1693 at Faulby, near Pontefract, in England, undertook the task, and succeeded after repeated attempts, covering the period 1728–1761. His first timepiece was made in 1735; the second in 1739; the third in 1749; the fourth in 1755, the year of the great earthquake at Lisbon. In 1758 his instrument was sent in a king's ship to Jamaica, which it reached 5″ slow. On the return to Portsmouth, after a five months' absence, it was 1′ 5″ wrong, showing an error of eighteen miles and within the limits of the act. He received the reward of forty years' diligence in instalments. He died in 1776.

Fig. 1285.



Chronometer.

Arnold made many improvements, and received government rewards amounting to £3,000.

Mr. Denison states that Earnshaw brought the chronometer to its present perfection.

The principles of the compensation balance are explained under COMPENSATION BALANCE (which see).

a a′, box and its lid.

b, chronometer suspended in gimbals.

c, chronometer balance.

Chronometers are known as *ship's* and *pocket*.

The rating of chronometers is usually conducted at government observatories.

The instruments are sent from the different watch-makers and received at stated periods. They remain the greater part of a year, their rates being noted daily by two persons. The best receive prizes and are purchased for the navy; others receive certificates of excellence; others are unrewarded. On their arrival in January, they are left to the ordinary atmospheric temperature for some months; their rates are taken under these conditions.

The apartment is then heated to a tropical temperature, and the rate taken.

They are then placed for a certain period in trays over the stove, and the rate taken.

They are then placed in a refrigerating chamber cooled by a freezing mixture, and the rate taken under this artificial arctic temperature.

Their capacity to stand these variations constitutes their value, and their actual range of exposure may be estimated at 180° — from the + 120° of

Aden and Fernando Po to the — 60° of the Arctic regions when frozen in the pack of ice and watching through the long, long night.

The two columns on which most reliance is placed in the schedule of performances are : —

a. "Difference between greatest and least rate."

b. "Greatest difference between one week and the next."

2. (*Music.*) An instrument to indicate musical time. A *metronome.*

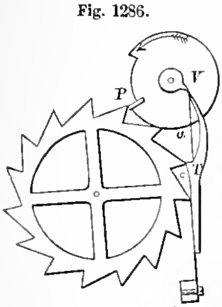
Chro-nom′e-ter–es-cape′ment. The chronometer-escapement was invented by Berthoud, and improved by Harrison, Arnold, Earnshaw, and Dent. It is the most perfect, delicate, and satisfactory in its operation, of all the escapements. It is also kept more carefully, at least in marine chronometers, as the gimbal-joint hanging enables it to maintain a constant position relatively to the horizon, and it is carefully guarded from jars.

There are several points which distinguish it from other escapements, and several which it has in common with one or more of the others.

The piece carrying the *detent-pallet* is a spring, and its motion to free the tooth of the escape-wheel is by the contact of a pin or tooth on the verge with a secondary spring attached to the former.

As the balance oscillates in the direction of the arrow, its tooth *V* comes in contact with the secondary spring *a*, and presses the lever, so that its tooth *T* is freed from the tooth of the escape-wheel. A ruby pallet *P* on the verge receives the impact of another scape-tooth, and the balance receives its impulse thereby. As the balance returns, its verge-tooth *V* presses past the spring without moving the lever which rests against a stop. The impulse is communicated from the scape-wheel direct to the balance-arbor, as it is also in the *duplex* movement, not as in the *lever* movement where a pivoted lever intervenes.

Fig. 1286.



Chronometer-Escapement.

Arnold's chronometer-escapement is substantially the same ; a secondary spring attached to the spring-lever is made effective in vibrating the latter when moved in one direction, and in the other is so pliable as to allow the verge-tooth to pass freely. As just explained, the stroke which raises the spring-lever withdraws the detent from the tooth of the scape-wheel, and at the same time that this tooth escapes, another strikes a pallet on the arbor of the balance, and restores to the balance-wheel the force lost during a vibration.

The free movement of the balance is only opposed at one point during a complete oscillation.

Chro′no-met′ric Gov′ern-or. A device by which a time-measurer set to work at a prescribed and equable rate is made to regulate the motion of an engine. Invented by Wood and improved by Siemen.

Chron′o-scope. Invented by Professor Wheatstone in 1840, to measure small intervals of time. It has been applied to ascertaining the velocity of projectiles. In Pouillet's chronoscope, a galvanic current of very short duration makes a magnetic-needle deviate, the duration of the current being measured by the amount of deviation ; by this means as short a time as some thousandths of a second can be measured. Schutz's chronoscope was employed by the Ordnance Department at the experimental firings at Fortress Monroe. The apparatus, operated by electricity, is described as follows : — Two wire targets are placed, one about twenty yards from the gun, and the second about the same distance farther on. These are connected by a fine insulated wire with the instrument, which is about 400 yards in the rear of the ordnance. The instrument is adjusted on a plan similar to an electro-ballistic machine. When the shot is fired, it cuts the wire in the first target, and then in like manner cuts the wire in the second target, the instant each wire is severed being recorded by the instrument. The interval of time occupied by the ball in passing from one target to the other furnishes the data for obtaining the initial velocity of the shot.

Noble's chronoscope is used for measuring the velocity of the shot during its passage through the gun. The ball presses upon a series of disks which in moving break or make electric connections, which are recorded on a rapidly rotating disk which has a known rate.

Chrys′o-type. (*Photography.*) A process by Sir John Herschel in which a sheet of paper is satuated with a solution of ammonio-citrate of iron dried in the dark. Exposed in a camera or printing-frame, the faint picture is developed by brushing over with a neutral solution of chloride of gold washed in water repeatedly, fixed by a weak solution of iodide of potassium, and then finally washed and dried.

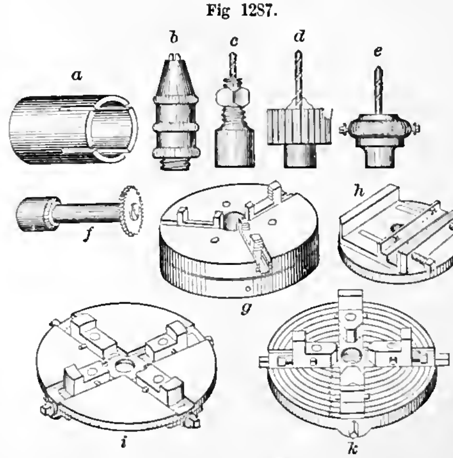
Chrys-tal′lo-type. (*Photography.*) A name given to a kind of picture on a translucent material. *Opalotype.*

Chuck. 1. An appendage to a lathe. Being screwed on to the nose of the mandrel, it is made to grasp the work to be turned. There are several varieties, as —

Arbor.	Geometric.
Branch.	Oblique.
Centering.	Oval.
Concentric.	Plain.
Driver.	Prong.
Eccentric.	Ring.
Elastic.	Screw.
Epicycloidal.	Surface.
Expanding.	Universal.

An *expansion* or *elastic* chuck *a*, having a certain range of capacity, may be formed by giving a quad-

Fig 1287.



Expansion Chuck.

rafid cleft to the end of a cylindrical tube, whose other end screws on to the threaded mandrel of the lathe-head. The object to be turned is thrust into the chuck, expanding the quadripartite socket.

b is Beach's patent drill-chuck.

c, center-drill chuck.

d, Warwick chuck.

e, Morse's adjustable chuck.

A circular saw of small diameter may be mounted on a lathe-chuck *f*, which has an axial tenon to fit the hole in the saw, and a central screw or nut to fix the same.

Opticians use this mode for the small, thin saws with which they cut the notches in the tubes serving as springs in pocket-telescopes.

Carvers in ivory mount their saws in a similar manner. The saws for cutting the nicks in screw-heads, and those for making slits in gas-burners, may be chucked or mounted on a mandrel.

The small, wooden mechanism for the interior of pianos is cut by saws similarly mounted.

g is a scroll chuck with three radially adjustable dogs.

h is a planer chuck.

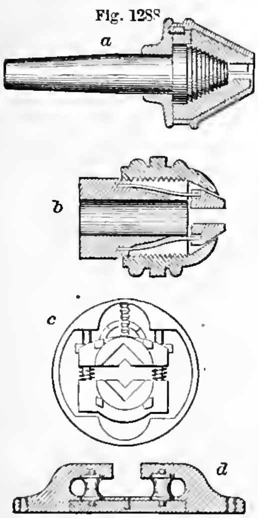
i is a screw chuck.

k is an independent jaw chuck.

The *eccentric chuck* is designed for changing the center of the work, and consists of two principal pieces; one attachable to the mandrel of the lathe and the other adjustable in a plane at right angles to the axis of motion, in a dovetail groove of the former piece. The sliding-piece is moved by a set screw.

The *elliptic* or *oval chuck* was invented by Abraham Sharp, and consists of three parts, the *chuck*, the *slider*, and the *eccentric* circle. The chuck is secured to and partakes of the circular motion of the mandrel. In front of the chuck is a dovetail groove for the reception of a slider, from the center of which projects a screw to which the work is attached. As the work turns round, it has a sliding motion across the center which generates an ellipse. The sliding motion is produced by an eccentric circle or ring of brass fastened to the puppet of the lathe close to the collar in which the neck of the mandrel runs.

Fig. 1288.



Chucks.

A *straight-line chuck* is used in a *rose-engine* when the patterns are to be made to follow a straight instead of a circular direction.

A *geometric chuck* has a radial slider to which the work is attached, and this is so governed as to give a combined circular motion and radial oscillation to the work relatively to the tool. See GEOMETRIC-LATHE; ROSE-ENGINE.

Fig. 1288 shows three forms of lathe-chucks having jaws to grasp the tool or the work, as the case may be.

a. The stock of the chuck terminates in a conical, threaded head, which opens or closes the jaws, which are threaded, and slide in grooves in the conical shell.

b. The nut has a conical opening in the end which operates against the inclined backs of the jaws, to clamp them upon the drill; when relieved they are expanded by springs.

c. This chuck belongs to that class which is constructed with screws for the purpose of operating the jaws. It is provided with a double screw, the pitch of one being just half that of the other, to operate the jaws simultaneously in opposite directions so that they will approach or recede from the center at equal speed, thereby forming a self-centering mechanism.

2. (*Nautical.*) *d* is a *warping chuck* in which hawsers or ropes run. Friction rollers prevent the wearing of the rope. It is used on the rail or other portion of a ship's side.

Chuck-lathe. A lathe in which the work is held by a socket or grasping device attached to the revolving mandrel of the head-stock. It is used for turning short work such as cups, spools, balls, and a great variety of ornamental and useful articles. See CHUCK.

Churn. A vessel in which milk or cream is agitated to induce the separation of the oily globules from the other portions.

The ancient mode of making butter was probably the same as practiced by the Bedouin Arabs and the Moors in Barbary at the present day. The cream is placed in a goat-skin and agitated by hand or by treading it with the feet.

The butter and honey mentioned by Isaiah vii. 15, is to this day an article of food in the East. The butter and honey are mixed and the bread dipped in it.

The word *chamea*, rendered *butter* in our translation of the Bible, seems to have referred to several forms of milk and its productions, such as sweet or sour milk, cream, thick milk, curd, or butter. The latter is perhaps the most infrequent form of its use, but is evidently intended in those passages where the article is used for anointing. It was "butter of kine and milk of sheep" that made Jeshurun "wax fat and kick." Abraham "took butter and milk and the calf which he had dressed and set before" three stranger visitors. Sisera "asked water, and" Jael the wife of Heber the Kenite "gave him milk; she brought forth butter in a lordly dish" before she nailed him to the ground with a tent-pin and a hammer. Job refers to the time when he anointed his feet, or as he expressed it, "washed my steps with butter, and the rock poured me out rivers of oil." "Surely the churning of milk bringeth forth butter." The reader can pick out the various probabilities of each case for himself. It must be mentioned, however, that the word rendered *churning* may be just as correctly rendered *pressing*, and may refer to the pressing of curd to rid it of the whey. Sweet milk occupied but a limited space in the Oriental economy, ancient or modern. It necessarily became soon soured, and they accepted the situation. The *leban* (coagulated milk) of the Arabs was and is the usual form in which milk is used.

The Turks yet show their Tartar origin in the preference for sour over sweet milk.

We have a mention of butter in the description of the Scythians by Herodotus (*b.* 484 B. C.). "These people," says he, "pour the milk of their mares into wooden vessels, cause it to be violently stirred or shaken by their blind slaves, and separate the part that arises to the surface, as they consider it more valuable and more delicious than that which is collected below it." This is evidently *butter*.

Hippocrates (460 B. C.) describes the process more clearly, stating that the lighter portion (butter) rises to the top, and the other part was separated into a liquid and solid portion (*curd* and *whey*), of which the former was pressed and dried (*cheese*).

This butter is recommended by this "father of medicine" as an ointment, and subsequently by Galen, A. D. 131.

The poet Anaxandrides, describing the wedding of Iphicrates, who married the daughter of Cotys, king of Thrace, wondered that the latter people *ate* butter.

The references to butter are occasional only ; by Aristotle, who speaks of it as the oily part of milk ; by Strabo, who speaks of its use by the Ethiopians ; by Plutarch, who speaks of a Spartan lady anointed with butter, and smelling so loudly that Berenice, her hostess, positively could not stand it. Berenice on her part smelt so strongly of rancid oil, that the Spartan was happy to leave.

Dioscorides and Galen refer to the use of butter as a substitute for olive-oil as a dressing for table use or for leather. Lamp-black, obtained by the burning of butter, they recommend for an eye-salve.

Pliny describes the use of butter and cheese by the "barbarous" Germans. The Romans used butter for anointing, the Germans for a hair-dressing, the Egyptians for burning. None of them probably knew the taste of good, hard, clean butter.

The Christians of Egypt used butter instead of oil in their lamps in the third century. It was easier to raise cattle than olives, apparently, in that land where it is said it now costs less than three dollars to raise a child to maturity.

The Arabians and Turks have a preparation of curdled milk, called *leben* by the former and *yaourt* by the latter, which they preserve in bags. In appearance it resembles pressed curds after they have been broken by the hand ; mixed with water it becomes a cooling drink, and is said to be wholesome and serviceable in febrile diseases. It probably formed the last meal of Sisera.

Fresh *yaourt* is much used as food by the natives, and Europeans soon acquire a taste for it.

The butter received at Constantinople from the Crimea and Kuban is not salted. It is prepared by melting in large pans and skimming off the impurities which rise to the surface. Butter thus prepared is called *ghee* in India. It is used for food by some castes and for anointing. Ghee is used to soak the wood on which the victim of the *suttee* is sacrificed.

The classes and varieties of churns are so numerous that justice cannot be done to the subject within admissible bounds. The following classification, with an example of each, will afford a glance at the distinctive kinds.

1. The *plunger* churn. *a* represents the vertical-dasher plunger churn. A spring assists in the recoil or lifting motion. Rotation of the dasher may be given by a spiral on the stem, or by giving a spiral set to the blades.

b is a horizontally operated dasher churn.

2. *Barrel* churn. *c* has a pair of dashers revolving in different directions by distinct cranks. In a modified form, the barrel is mounted on trunnions and is itself rotated.

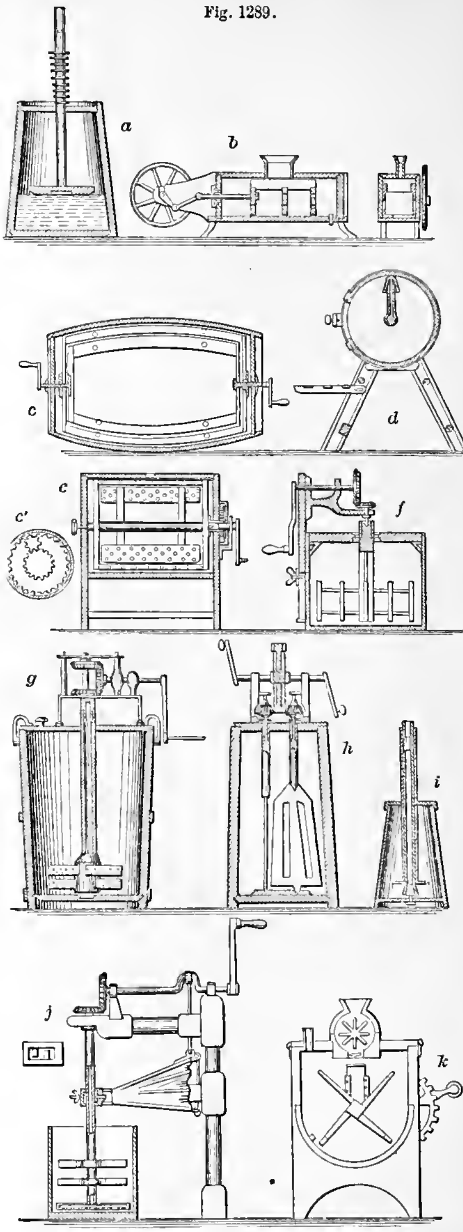
d has a stationary barrel and one rotated dasher.

3. *Box* churn. *e* has two dashers revolving at different speeds. The inner dasher is driven by the crank-axis direct ; the outer one by an internally geared wheel, a pinion, and a third wheel on the sleeve which carries the dasher. The arrangement of wheels is shown at *e'*.

4. *Tub* churn. *f* has a vertical dasher-shaft rotated by wheel and pinion from the crank-shaft.

g has two dashers rotating in different directions, one driven by the central axis and the other by the sleeve axis. Each axis has its own pinion, driven by a common wheel.

Fig. 1289.



Churns

h has a pair of parallel dashers driven in contrary directions by the master-wheel, which acts upon the respective pinions.

5. *Atmospheric* churn. *i* ; as the dasher rises, the valve on the upper end of its stem falls and admits air, the valve on the hollow guide-rod closing. As

the dasher descends, the action of the valve is reversed, and the air issues into the milk at the openings in the lower end of the hollow stem.

j has a bellows arrangement supplementary to the beating action of the dashers.

There are many other varieties of atmospheric churns; some have cup-shaped dashers, to carry air down into the milk; others operate by centrifugal action.

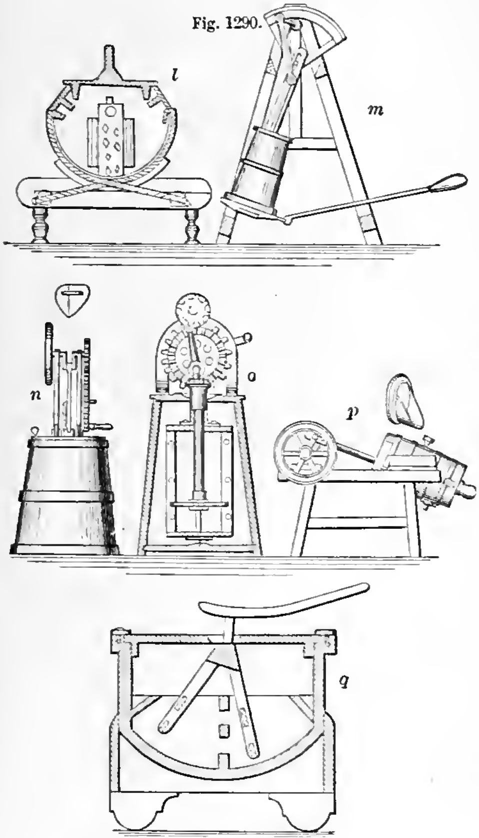
6. *Compressor* churns. *k* has a rubbing or grinding action on the cream in the upper chamber, the intention being to break the little sacs which contain the butyric particles.

7. The *Rocker* churn, *l*, Fig. 1290.

8. The *Pendulum* churn, *m*.

The churn rests in the swinging frame, the uprights of which are slotted for traverse of the axial

Fig. 1290.



Churns.

pin, and have segmental bars bearing upon the dasher crank-shaft, and causing its reciprocating rotation.

9. The *Divided* dasher churn, *n*, has a pair of dashers vertically reciprocating and operated by the respective cranks on the common shaft.

10. The *Revolving* and *Reciprocating* churn, *o*; the shaft carries a rotary dasher whose wings act as slides for the arms of a reciprocating dasher. An inner sleeve carries the reciprocating dasher and passes through an outer sleeve carrying the pinion of the rotary arm.

11. The *Oscillating* churn, *p*; the cylinder is suspended on trunnions and oscillated by the reciprocating dasher-shaft, which is connected to the revolving crank.

12. The *Oscillating* dasher churn, represented at *q*.

13. The *Thermometric* churn, in which the box or the dasher-shaft has a thermometer to give constant indication of the temperature of the cream.

Numerous patents have been granted for matters of detail such as: —

Water-tanks for hot or cold water to temper the cream. Ivory bushings to prevent the taint of brass, or the rust of iron. Materials, such as glass, stoneware, etc.

An artificial butter is made from suet, which is first finely divided by circular saws in a cylinder; then treated with water, carbonate of potassa, and finely divided fresh sheep's stomachs at a temperature of 45° C. The pepsin and heat separate the fat, which floats on the surface, whence it is decanted, and when cool, placed on an hydraulic press, which separates the stearine from the semi-fluid oleomargarine, which is employed as follows in the preparation of the butter: 50 kilogrammes of the fat, 25 liters of milk, and 20 liters of water are placed in a churn; to this, 100 grammes of the soluble matter obtained from cows' udders and milk-glands is added, together with a little annotto. The mixture is then churned, when the butter separates in the usual manner.

In connection with this subject, we may be pardoned introducing a short account of how royalty churns by proxy and how nice a dairy may be made when "expense is no object."

Prince Albert's model farm is about a mile from Windsor Castle. The dairy is a beautiful cottage with a marble-paved and frescoed vestibule. The interior is a room about thirty feet square, the roof supported by six octagonal columns of white marble, with richly carved capitals. The floors are of white porcelain tiles, the windows stained glass, bordered with hawthorn blossoms, daisies, buttercups, and primroses. The floors are lined with tiles of porcelain of a delicate blue tint, with rich medallions inserted of the Queen, Prince Consort, and each of the children. Shields, monograms of the royal family, and bas-reliefs of agricultural design, representing the seasons, complete the ornamentation of this exquisite model dairy. All around the walls runs a marble table, and through the center two long ones, supported by marble posts, resting on basins through which runs a perpetual stream of spring water. By this means the slabs of table are always cold, and the temperature of the dairy is chill, while the white and gilt china milk and butter dishes resting on the tables are never placed in water. The delicious milk is brought in in bright metal buckets, lined with porcelain, the Queen's monogram and crest glittering on the brass plates on the covers. In the room where the butter is made, milk skimmed and strained, the eyes may be feasted on the rows of metallic porcelain-lined cans of every size, made to lock, and sent to the royal family even as far as Scotland; so they always have good milk and butter. The churn was of metal also, and lined with porcelain, made in two compartments. The outside chamber surrounding the cylinder can have warm or cold water poured in to regulate the temperature. The lid is screwed on, and the stationary stand on which the whole is turned makes the work easy and rapid. But while over sixty cows are daily milked, and as many more are out grazing, the royal family are more than satisfied, and the Londoners growl that the overplus is sold and the money pocketed by their money-saving sovereign.

2. (*Porcelain.*) The block or chuck on a porcelain turner's lathe, on which the thrown and baked articles are turned by thin iron tools to give truth and smoothness to circular articles.

Churn-dash′er. The moving agent in a churn, rotary or reciprocating, by which the milk or cream is agitated.

Churn-drill. A large drill used by miners. It is several feet long, and has a chisel-point at each end.

Churn-pow′er. A motor for driving churns or churn-dashers to agitate the milk or cream.

Animals, such as dogs, sheep, or goats, are employed in treadmills or slatted platfroms on endless belts.

The power of descending weights, springs, wind or water driven wheels, etc., are used.

Chute. An inclined trough.

On a moderate scale it forms a leader, or feeder for materials or blanks, to machines.

On a large scale it leads water from a penstock to a water-wheel, or an inclined plane down which logs are passed from a higher level to a lower one. These are sometimes in mountainous countries for land transportation, and sometimes are the links of a slack-water system, as on the Ottawa; called *slides.*

Ci-bo′ri-um. (*Architecture.*) An insulated arched vault resting on four pillars, as that over the high altar of a church.

Ci′der-mill. A grinder for apples generally, in practice, including the press in which the pomace is pressed.

The common cider-mill *a*, used in the Southwest of England, is on the principle of the Chilian mill, being a cylindrical stone weighing one or two tons, and rotating in an annular trough of masonry.

The axis of the stone is connected by arms to a sweep which is pivoted on a central post and revolved by a horse. In some cases the central space forms compartments for holding apples. The roller is from 2½ to 4½ feet in diameter, and 9 or 10 inches wide at the face. The trough is somewhat wider at top by the inclination of its outer side, to allow freedom of motion to the runner. The bed is from 9 to 12 feet in diameter.

Cider-mills in England are also made with hollow iron fluted rollers, working in pairs and meshing into each other.

In Ireland the apple is crushed between wooden cylinders studded with iron teeth; the pomace is afterwards pounded with wooden pestles.

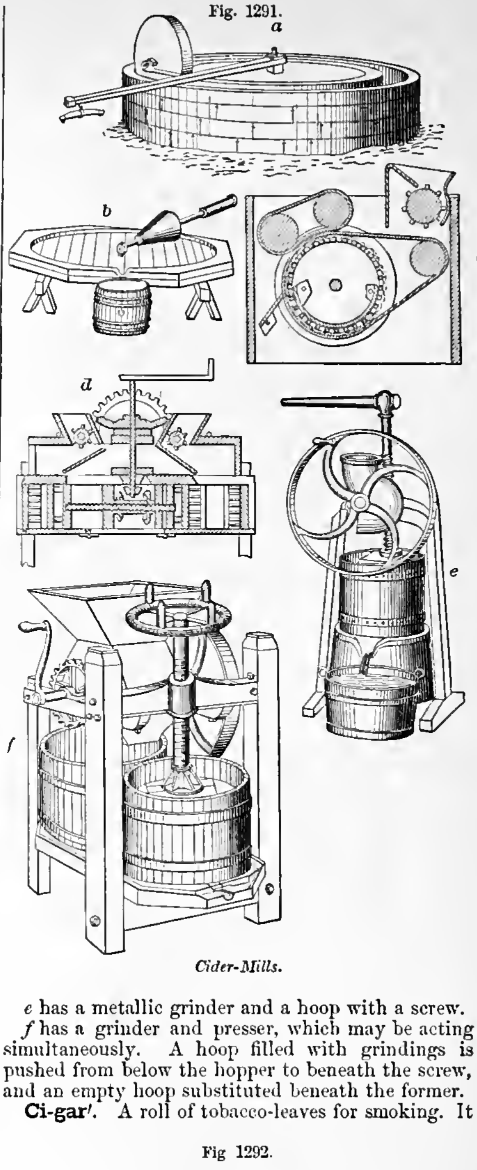
The *cider-press* of the West of England is a modification of the common screw-press. The pomace is enclosed in a bag of haircloth about 4 feet square, and holding two or three bushels. These are heaped over each other in the press, to the extent of fifteen or eighteen bags. These yield from 100 to 200 gallons of juice, according to number and the succulency of the apples. The press-screw is manipulated by a lever.

The *cider-mill* (*b*) used in the South of France has a platform of boards framed together and is traversed by a conical frustum of cast-iron whose axis is hooked to a rotating eye in the center of the platform and is swept around by manual power, crushing the fruit in its passage.

The mill *c* has a grinding-wheel and concave, and an apron which carries the pomace between two pressing rollers and a wire-screen cylinder through which the juice runs.

d has alternate grinding portions and a double-headed piston, which presses the pomace against the ends of the box alternately. One end of the box is filling while the other is pressing.

Fig. 1291.



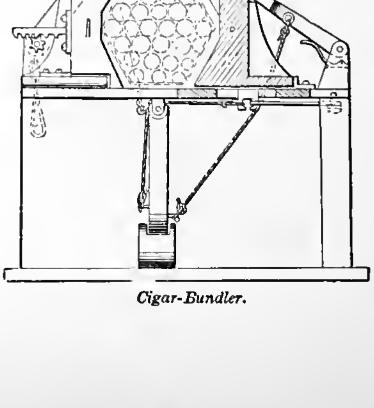
Cider-Mills.

e has a metallic grinder and a hoop with a screw.

f has a grinder and presser, which may be acting simultaneously. A hoop filled with grindings is pushed from below the hopper to beneath the screw, and an empty hoop substituted beneath the former.

Ci-gar′. A roll of tobacco-leaves for smoking. It

Fig 1292.



Cigar-Bundler.

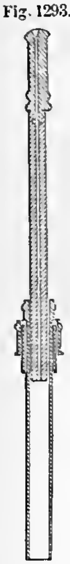
has a pointed mouth-end and a square-butted lighting-end. The word is derived from Spanish *cigarro*, a kind of tobacco grown in Cuba. Also spelt *segar*. The *cheroot* is the cigar of the Manillas, and has a regular taper, but both ends are squarely cut off, one of course is smaller than the other.

Ci-gar′-bun′dler. A clamping-press having jaws of such shape and capacity as the size of the cigar and the number desired in a bundle may warrant. The required number being placed between the jaws, the latter are drawn together by the pressure of the foot on the stirrup and cord, and the jaws locked by an arm while the tie or band is placed around the cigars.

Ci′gar-ette′. A small package of cut tobacco done up in a rolled paper envelope. The envelope is made of rice, tobacco, or corn-husk. The latter is the best.

Ci′gar-ette′-fill′er. A little implement for introducing the finely cut tobacco into the paper envelope. It has two forms; a tube and a wrapper. The former is shown in Fig. 1293. A roll of paper is wrapped around a tube, and its inner end clamped between two short tubes or collars; the tube is filled with tobacco and withdrawn, leaving the tobacco in the paper envelope. A hollow piston maintains the position of the tobacco while the tube is withdrawn and forms a stem.

Fig. 1293.

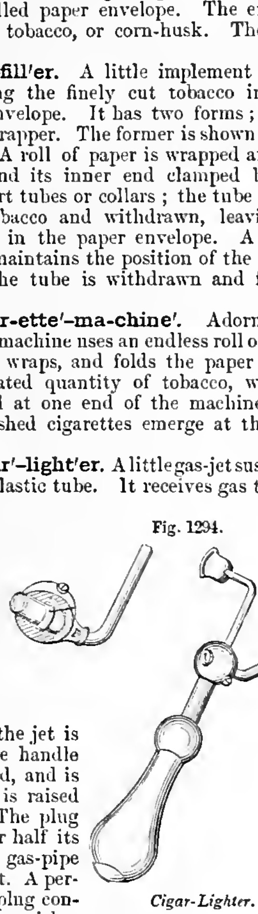


Cigarette-Filler.

Ci′gar-ette′-ma-chine′. Adorno's cigarette-machine uses an endless roll of paper. It cuts, wraps, and folds the paper around a regulated quantity of tobacco, which is supplied at one end of the machine, while the finished cigarettes emerge at the other end.

Ci-gar′-light′er. A little gas-jet suspended by an elastic tube. It receives gas through its trunnions; the jet is decreased as the handle hangs suspended, and is increased as it is raised for lighting. The plug is chambered for half its length, and the gas-pipe is screwed into it. A perforation in the plug connects the interior with a channel on its periphery and in the socket, the channel being regulated by a screw.

Fig. 1294.



Cigar-Lighter.

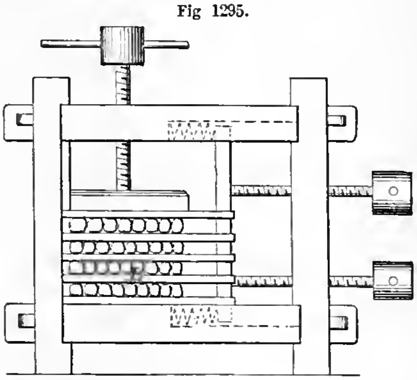
Ci-gar′-ma-chine′. For making fillers of cigars and wrapping them. The operations are generally conducted in a series of machines: one cuts wads of cigar length and quantity from a stream of cigar-leaves packed and traversing in a chute whose width is equal to the length of a cigar; the wad thus cut off is driven into a mold which gives it the cigar-shape, and in this it is left to dry, so that when removed it only requires the wrapper to complete it. This is put on in another machine in which the filler is laid bias upon the strip of leaf, and rolled thereon, a pad or apron simulating the action of the human palm. The tip is finished separately, and then the stub-end cut off squarely.

Another mode of procedure is to lay a suitable bunch of leaves in an apron which is lapped around them so as to form them into a sufficiently tight roll; or the rolling device consists of a set of cylinders in a circular series, which opens to admit the bunch of leaves, and when closed forms a cylindrical space in which the bunch of leaves is rolled and pressed into a shape for the molds in which it is eventually pressed to the required shape for a filler. The latter is covered by hand or by a machine.

Ci-gar′-press. A press having a motion in two directions: one to compress the cigars in their rows, and the other to press them vertically.

The press has side-screws working horizontally, and a vertical screw so placed as to be over the stack

Fig 1295.



Cigar-Press.

containing the cigars; the side press-board slides in the slotted sides of the horizontal boards. The cigars are arranged upon the boards with intervening slats.

Ci-gar-steam′er. A peculiar form of craft, shaped like a spindle, and constructed by Winans, of Baltimore.

The first was built in Baltimore — length, 635 feet; diameter, 16 feet.

Second, in St. Petersburg — length, 70 feet; diameter, 9 feet.

Third, in Havre — length, 72 feet; diameter, 9 feet.

Fourth, in Isle of Dogs — length 256 feet; diameter, 16 feet.

The propeller of the first was placed around the middle of the vessel; the second had a propeller beneath her bottom; the third is fitted for trying propellers in various positions; and the fourth has a propeller at each end.

Cim′e-ter; Scim′e-ter. An Oriental cavalry sword with a blade of great curvature.

Cinc′ture. (*Architecture.*) A fillet or ring dividing the capital from the shaft. Another cincture divides the latter from the base.

Cin′der. 1. A scale of oxide removed in forging.

2. Certain kinds of light slag in metallurgic operations.

Cin′der-frame. (*Steam-engine.*) A wire-work frame in front of the tubes of a locomotive, to arrest the passage of large pieces of ignited fuel.

Cin′que-foil. (*Architecture.*) A five-leaved ornament used in the arches of the lights and tracery of windows, panelings, etc.

Ci-on′o-tome. An instrument for excising a portion of the uvula.

Ci'per-tun'nel. A false chimney placed on a house for ornament or uniformity.

Cip'pus. A low column, sometimes round, but more frequently rectangular, used as a sepulchral monument.

Cir-cas'si-enne. (*Fabric.*) A light kind of cashmere.

Cir'ci-nus. The compass of the Romans, described by Vitruvius.

Cir'cle. 1. This plane figure — comprehended by one line, every part of which is equally distant from the same point — gives a name to a number of instruments, among which are the following (which see): —

Mural circle.	Circumferentor.
Reflecting circle.	Circular saw.
Repeating circle.	Circular shears, etc., etc.

2. The fifth wheel of a carriage.

Cir'cle-i'ron. 1. A hollow punch for cutting planchets, wads, wafers, and circular blanks.

2. A *fifth wheel.*

Cir'cuit. A continuous electrical communication between the poles of a battery.

(*Telegraphy.*) The wires and instruments forming the road for the passage of the current. At its extremities are the terminals, where it joins the instrument.

A *metallic* circuit is when a *return wire* is used instead of the earth.

A *short* circuit is one having as little resistance as possible; nothing but the apparatus and the wire used to connect it with the battery.

To *short circuit a battery* is to connect its poles by a wire.

A *local* circuit includes only the apparatus in the office, and is closed by a *relay.*

Cir'cuit-break'er. (*Telegraphy.*) An instrument which periodically interrupts an electric current. The name *Rheotome* was given to it by Wheatstone.

With the automatic apparatus, the circuit is closed through the armature to and through the electro-magnet by which it is controlled. When thus closed to the magnet, the latter attracts the armature, breaking the circuit. The armature is then retracted, so that the circuit is again completed, and so on.

The simplest and first form of rheotome or circuit-breaker was a file connected to one wire of a battery, the other wire being rapidly drawn over the surface of the file alternately in contact with a tooth and hopping to the next one.

Another form is a spur-wheel moved by hand or clock-work; this is common in telegraph instruments and in electro-magnetic machines.

Cir'cuit-clos'er. (*Telegraphy.*) Primarily any device by which an electrical circuit is closed. Usually a key; as the common telegraph key.

In fire alarms and many automatic telegraphs, it is a plain metallic disk with insulated spaces on the rim or edge. A flat spring pressing upon the edge closes the circuit when upon the metallic portion, interrupts it when on the insulated portion. See DIAL.

In place of metallic and insulated spaces, projections or cogs are sometimes used, the interdental spaces answering the purpose of insulated spaces.

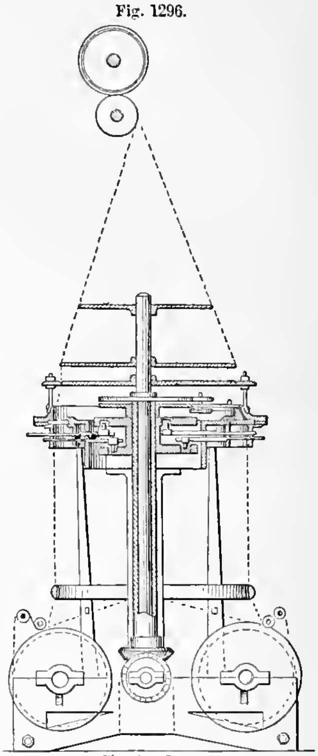
Cir'cu-lar Bolt. A machine employed by the Nottingham, England, lace manufacturers in making net.

Cir'cu-lar File. A circular saw or serrated disk, adapted to run on a spindle or mandrel, and used in cutting teeth of cog-wheels.

Cir'cu-lar In'stru-ments. Astronomical, nautical, or surveying instruments which are graduated to 360°, that is, around the whole circle. Of this kind are *altitude, azimuth, mural, reflecting,* and *repeating circles; circumferentors* (which see).

Cir'cu-lar Loom. A loom in which the shuttle moves in a circular race and continuously in one direction through warps arranged in a circle. The cut shows a loom of this class; the warps proceed from beams or creels near the floor, pass through a ring which brings them in a circle, then through eyes in horizontally reciprocating slides which form the shed, then through between the dents of the circular reed to the take-up mechanism. The shedding-slides are moved by cams on the main vertical shaft. The shuttle is sustained by and moves on the dents of the reed, and is driven by means of an arm provided with a roller which presses against the head of the shuttle and allows the passage of the warp between them. The shuttle may be provided with a projection to beat up the filling, or comb-like arms made in sections may be made to beat the filling between the warps.

Fig. 1296.

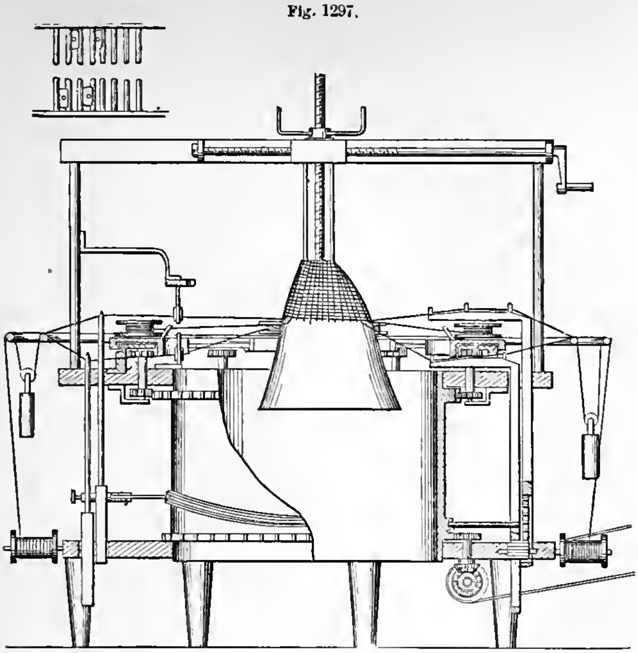


Circular Loom.

Another form is one in which the material is woven around a former which gives it size and proportion, as in Fig. 1297, which is a machine for weaving petticoats and hoop-skirts. The fabric is woven around a block suspended between the warp-carriers and the track of the shuttles, said block being movable vertically and laterally, in order that it may be adjusted centrally. The shuttles move on a circular or other endless track, and deposit their woof threads alternately above and below a warp thread around the block. The warp-carriers receive an alternate vertical reciprocating motion from a cam on a revolving drum, from which the shuttles also derive their motion.

The warp-threads have to be spread, so as to have them equidistant from each other around the block. For that purpose the carriers have horizontal extensions, which are diverging, like spread fingers, so that the desired effect is produced, and the desired distance between the warp-threads obtained, without requiring the spreading of the carriers, which are arranged in groups of six, more or less. To diminish friction in the operation of the carriers,

Fig. 1297.



Circular Weaving-Loom.

such grouping is necessary, as otherwise each carrier would require its own connection with the cam on the drum.

The cam only operates one set of each group of carriers, and the carriers, which are thus alternately raised and lowered, impart, by means of gearing or otherwise, motion to the other set of carriers, so that the same always moves in the opposite direction with the first-named set.

Cir'cu-lar Mi-crom'e-ter. The *circular* or *annular micrometer* was first suggested by Boscovich in 1740, and was afterwards revived by Olbers in 1798. The principle is as follows: —

"If the field of a telescope be perfectly circular, and its diameter be determined by observation, the paths of two celestial bodies across the field may be considered as two parallel chords which are given in terms of a circle of known diameter. The differences of the times at which two stars arrive at the middle of their paths will be their ascensional differences; and the distance between the chords, which is readily computed from their lengths, gives the difference of the declination of the two bodies." — BRANDE.

The annular form devised by Fraunhofer is the more convenient instrument, as it permits the moment of ingress and egress to be determined more readily. It consists of an annular glass disk with a steel ring cemented on the inside to form the circular aperture as before described.

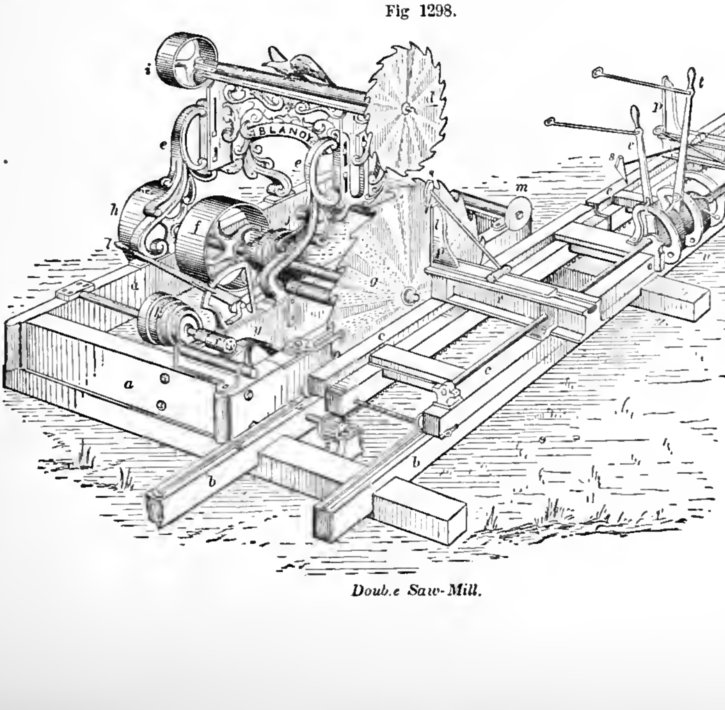
Cir'cu-lar Saw. The circular saw was introduced into England about 1790, but its inventor is not known.

General Bentham contrived the bench, slit, parallel guide, and sliding bevel guide. He also invented making circular saws of segmental plates.

One was patented in England by Trotter, 1804. Brunel's veneer-saw, 1805–1808.

The double saw-mill shown in the illustration is of the Blandy pattern, selected from a multitude of others as a good specimen of its kind. *a* is the frame of the saw-mill proper, *b* the ways on which the log-carriage *c* traverses. *g* is the lower saw, which may have an average diameter of, say, 60 inches,

Fig 1298.



Double Saw-Mill.

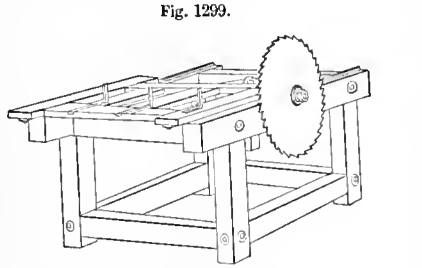
and a rate of revolution of, say, 500 to 600 revolutions per minute, varying with the kind of wood and the diameter of the saw. *d* is the upper saw, whose arbor has its bearings in the iron frame *e e*, which may be detached, with all its appendages, from the sill pieces *a a*, so that the machine then becomes a single saw-mill, the working radius of the saw being sufficient for the run of logs of the locality. *f* is the band-pulley of the lower saw, and *h i* are the pulleys by which the motion of the lower saw-arbor is communicated to the upper saw *d*. *j k* are the cone-pulleys concerned in the *feed* and *gig-back* motions of the log-carriage *c*. *l* is the lever by which the direction of motion of the carriage is regulated.

p p are the knees of the head-blocks *r r*, on which the log lies and is fastened by the dogs *s s*. These head-blocks are adjustable longitudinally on the carriage, according to the length of the log, and the knees of the head-block are set up closer to the saw after each cut of the saw, to a distance equal to the thickness of board required and the width of the kerf. The setting up of the knees is done simultaneously by the vibration of the lever *t*, which has a pawl acting upon each of the ratchets *u u'*. When it is desired to saw a board thicker at one end than at the other, the knees on the respective head-blocks are moved independently by the levers *v w* respectively, these levers having each a pawl to actuate that one of the ratchets *u* which belongs to the appropriate head-block.

The feed-motion of the carriage *c* consists of a friction-wheel *x* on the pulley *y*; on the arbor of the latter is a pinion *z*, which meshes with the rack on the under side of the log-carriage. The direction of rotation of the pinion *z* determines the feed or gig-back motion, which is controlled by the position of the lever *l* on the quadrant. *m* is a revolving wedge which enters the kerf and spreads the board from the log.

One form of circular saw for cross-cutting cord-wood, or butting framing-timber, is shown in the an-

Fig. 1299.



Butting-Saw.

nexed cut. The wood lies upon a sliding-frame and is pushed toward the saw and drawn back by hand.

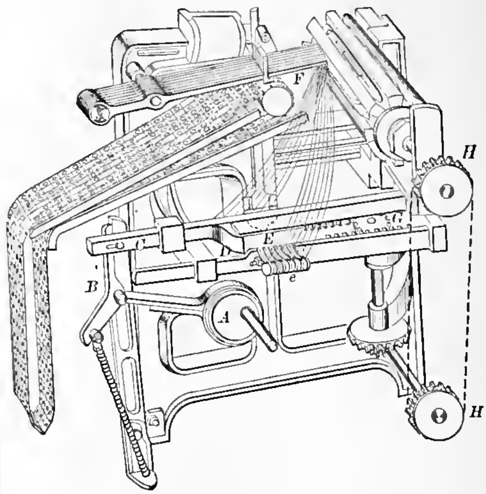
Saws are made in Trenton, New Jersey, 88 inches in diameter, with 48 insertable teeth, and, allowing 6 inches for collars, are adapted to cut boards 41 inches wide. Such a saw is designed to make 375 to 400 revolutions per minute, to cut 6 inches to a revolution, and is declared capable of cutting 50,000 feet of inch lumber in ten hours.

Cir'cu-lar Shears. A shears for sheet-metal consisting of two circular blades on parallel pins.

Cir'cu-lar Shut'tle-box Loom. A loom having a box with a number of shuttles, six in the figure, and having means for actuating it so as to bring any one of the six shuttles into operation as required by the pattern. The circular shuttle-box is mounted on an axle at one end of the sley, and has a positive revolving motion given to it, when required to change a shuttle, by a chain *H* actuated by gearing *G* in connection with two racks, the amount of motion being regulated by tumblers connected to jacks or levers governed by Jacquard cards.

A is an eccentric connected to a lever *B*, for giving motion to the sliding bar *C*, furnished with projections *D*, which act upon tumblers *E* when

Fig. 1300.



Circular Shuttle-Box Loom.

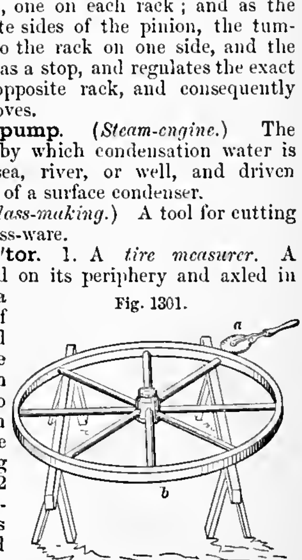
they are lifted by the cards connected to the jacks or levers *F*, which is whenever there is a blank in the part of the card opposite to the jack or lever. When these tumblers are lifted they fall into slots in the racks, and being caught by the projections *D*, the racks are carried forward and the pinion *G* turned; this gives motion to the upright shaft and bevel wheels, through them to the chain wheels *H H*, one of which is on the axle of the shuttle-box. Each jack or lever *F*, except the two end ones, is connected to two tumblers, one on each rack; and as the racks are on opposite sides of the pinion, the tumbler gives motion to the rack on one side, and the other tumbler acts as a stop, and regulates the exact distance that the opposite rack, and consequently the shuttle-box, moves.

Cir'cu-lat-ing-pump. (*Steam-engine.*) The cold-water pump by which condensation water is drawn from the sea, river, or well, and driven through the casing of a surface condenser.

Cir'cu-lus. (*Glass-making.*) A tool for cutting off the necks of glass-ware.

Cir-cum'fer-en'tor. 1. A *tire measurer*. A wheel, *a*, graduated on its periphery and axled in a holder. It has a circumference of known length, and is passed around the outside of the rim of a wheel, *b*, to ascertain the length of the tire. The instrument having a perimeter, say 2 feet in circumference, the zero is brought to a marked spot on the periphery of the wheel

Fig. 1301.



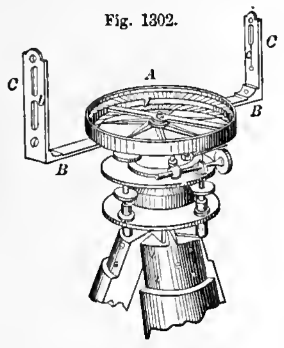
Circumferentor.

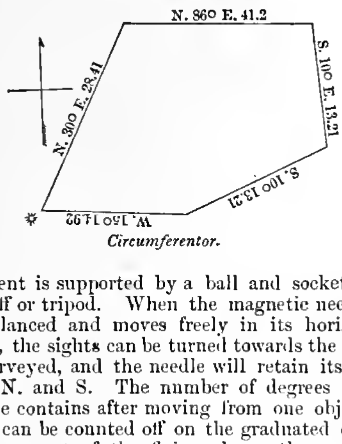
to be measured. The small wheel is then caused to travel around the larger, and indicates the length by making so many revolutions and such a fraction, as the case may be. A *tire-circle.*

2. A surveying instrument; used commonly in mines, coal-pits, etc., in England, but a very common instrument in the United States for surveying. Many of the old-fashioned surveyors yet use it, though it is disappearing as the theodolite becomes more and more commonly known.

It consists of a flat bar of brass *B B* about 15 inches in length, with sights *C C* at its opposite ends, and two narrow slits *b c* for observations; in the middle of the bar is a circular brass box *A*, containing a magnetic needle and covered with glass. The ends of the needle play over a brass circle *g*, which is divided into 360°, in such a manner that the two numbers of 90° are at right angles to the lines drawn through the sights. The

Fig. 1302.





Circumferentor.

instrument is supported by a ball and socket-joint on a staff or tripod. When the magnetic needle is well balanced and moves freely in its horizontal position, the sights can be turned towards the object to be surveyed, and the needle will retain its position of N. and S. The number of degrees which the angle contains after moving from one object to another can be counted off on the graduated circle. The lower part of the figure shows the mode of reading and plotting the bearings.

Cir'cum-flex. The mark ["∧"] over a vowel, indicating a certain accent.

Cir'cum-val-la'tion. (*Fortification.*) An encircling line of field-works.

Cir'cum-vent'or. A surveying instrument having a compass-box at top for taking angles. See CIRCUMFERENTOR.

Cir'so-tome. (*Surgical.*) An instrument used in the extirpation of a varix; that is, a varicose or dilated vein.

Cis'tern. 1. A tank or other form of artificial reservoir for containing a supply of water.

Cisterns have always been very common in lands subject to occasional abundant supply with intervals of drouth. In India cisterns are on a very large scale; in Egypt they assumed the proportions of lakes; in Ceylon are the remains of many on a scale far beyond the ability of the Cingalese population either to construct or utilize.

The change of domicile of the Israelites from a land of annual overflow to a land of rains, from a land of artificial irrigation to one of running waters, was cited as one of the peculiar advantages in their removal from Egypt to Palestine. "For the land whither thou goest in to possess it is not as the land of Egypt from whence ye came out, where thou sowedst thy seed, and wateredst it with thy foot, as a garden of herbs; but the land whither ye go to possess it is a land of hills and valleys, and drinketh water of the rain of heaven." — Deut. xi. 10, 11.

Yet even in Palestine cisterns were a necessity, the rains falling only in spring and autumn. The pools of Solomon are near Bethlehem, and are 3 in number, on the slope of a hill, and one above another, so as to form a chain of pools. The breadth of each is from 80 to 90 paces; the upper pool is about 160 paces, the second 200, the third 220. The water was conducted to Jerusalem.

The Romans built magnificent and elaborate cisterns, many of them on such a scale that they are called reservoirs. They made them every 20,000 feet in their aqueducts, to act as reserve and admit of repairing the conduit. Near the baths of Titus in old Rome are nine subterranean cisterns 17½ feet wide, 12 feet high, and about 137 feet long.

The baths were constructed with a number of separate lavatories, named according to the temperature, the *frigidarium*, the *tepidarium*, the *caldarium*, or *balneum.* These were made of masonry or concrete.

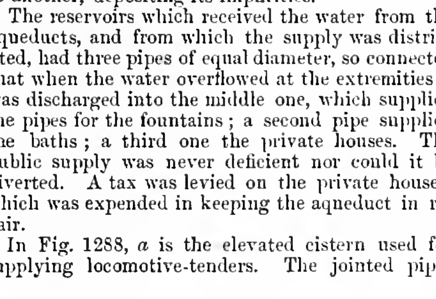
The material was broken stone and the best of mortar. The mortar was made of pure, clean sand, 5; lime, 2 parts. The stone was flint, of which no piece weighed over a pound.

Several divisions were made in the cisterns which were used for supply of water, which passed from one to another, depositing its impurities.

The reservoirs which received the water from the aqueducts, and from which the supply was distributed, had three pipes of equal diameter, so connected that when the water overflowed at the extremities it was discharged into the middle one, which supplied the pipes for the fountains; a second pipe supplied the baths; a third one the private houses. The public supply was never deficient nor could it be diverted. A tax was levied on the private houses, which was expended in keeping the aqueduct in repair.

In Fig. 1288, *a* is the elevated cistern used for supplying locomotive-tenders. The jointed pipes

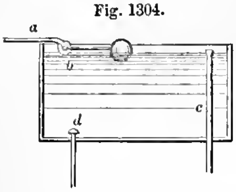
Fig. 1303.



Railway-Cistern.

c c are maintained in elevated position by counterbalance weights when water is not being discharged. On pulling them down, as shown in the figure, by means of an attached cord, a valve at the joint allows water to flow through them from the pipes *b b*, and into the reservoir of a tender standing on either of the tracks *d d*. This is also known as a *water-crane*.

Fig. 1304.



House-Cistern.

Fig. 1304 is the cistern used in houses when the water supply is intermittent; it has a *main-service* pipe provided with a *ball-valve*, a *house-service* pipe *a*, provided with a ball-cock *b*, and a rose to strain the water, a *standing waste*-pipe *c*, to allow excess of water to run off, and a *waste*-pipe *d*, which allows the cistern to be emptied for cleansing, when the *standing*-pipe is removed.

Capacity of Cisterns in Gallons for each Ten Inches in Depth.

Diam. in Feet.	Gallons.	Diam. in Feet.	Gallons.
2	19.5	8.5	353.72
2.5	30.6	9	396.56
3	44.6	9.5	461.4
3.5	59.97	10	489.6
4	78.33	11	592.4
4.5	99.14	12	705
5	122.4	13	827.4
5.5	148.1	14	959.6
6	176.25	15	1,101.6
6.5	206.85	20	1,958.4
7	239.88	25	3,059.9
7.5	275.4	30	4,406.4
8	313.33		

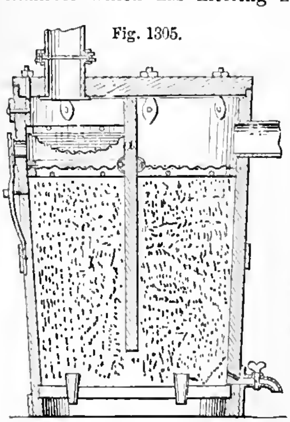
2. (*Mining.*) A tank in a deep mine shaft, set upon a *scarcement;* it serves to receive the water of the pump below, and supply water to the pump above. The usual length for a set of mining pumps in 25 to 30 fathoms. At such intervals *cisterns* are placed.

3. (*Steam-engine.*) The vessel inclosing the condenser of a condensing steam-engine, and containing the injection water.

4. (*Glass.*) The receptacle into which glass is ladled from the pots to be poured on the table in making plate-glass, or in casting glass. A *cuvette*.

Cis'tern-fil'ter. A cistern having a permanent chamber which has filtering material intervening between the supply and discharge. In Fig. 1305, the water passes through the filtering material down one side of the vertical axial division, and, after passing beneath it, rises upon the other side.

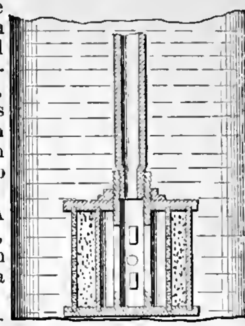
Fig. 1305.



Filtering-Cistern.

In Fig. 1306, the filter is at the lower end of the pump-stock. Two concentric cylinders are clamped between an upper and under disk, by means of an enlarged section of the pump tube. The annular space between the cylinders is filled with filtering material, and the cylinders are perforated on opposite sides, so that the water makes a partial circuit to reach the inner space which connects with the pump tube.

Fig. 1306.



Cistern-Filter.

Cis'tern-pump. A small pump, lift or force, for pumping water from the moderate depth of a cistern.

Cit'a-del. (*Fortification.*) An inner work capable of independent defence, but joined to the other works of a place.

Cith'a-ra. (*Music.*) An old kind of harp. The *cithern* is an Austrian stringed instrument. The *citole* is an instrument like the dulcimer. The *citeen* is an ancient instrument resembling the lute. See CITTERN.

Cit'tern. (*Music.*) An old kind of guitar.

"My lord [Sandwich] called for the lieutenant's cittern, and with two candlesticks with money in them for symbols (cymbals), we made barber's music." — PEPYS, 1660.

Civ'er-y. (*Architecture.*) A bay or compartment of a vaulted ceiling. A *severy*.

Civ'il En-gi-neer'ing. See under the following heads: —

Adobe.
Alignment.
Anchor-gate.
Anchor-suspension cable.
Angle of repose.
Aqueduct.
Arch.
Arched beam.
Artesian well.
Asphalte pavement.
Auger.
Baleine.
Ballast.
Bank protector.
Banquette.
Basalting.
Batter.
Battering plumb-rule.
Battery-head.
Beam.
Bearing-pile.
Beché.
Bed.
Bench.
Berme.
Béton.
Bevel plumb-rule.
Blasting.
Blasting-needle.
Blinding.
Bolt and spike extractor.
Boring wells.
Bottoming.
Bowstring-girder.
Box-beam.
Breakwater.
Breast-wall.
Bridge (varieties, see BRIDGE).
Bridge-stone.
Buckled plate.
Cable. Submarine.
Cable. Suspension-bridge
Caisson.
Camel.
Camp-sheeting.
Canal.
Canal-lift.
Canal-lock.
Canal-lock gate.
Carpentry.
Causeway.
Cendreé de Tournay.
Centering.
Chemise.
Claw bar.
Cob wall.
Coffer dam.
Compo.
Concrete.
Conduit.
Construction way.
Corduroy road.
Counter-fort.
Coursed masonry.
Cradle.
Crevasses. Stopping.
Crosette.
Crow-bar.
Crow's foot.
Cuddy.
Culvert.
Curb.
Cutling.
Dam.
Dead-wall.
Detonating-primer.
Digue.
Dike.
Ditching-machine.

Diving-bell.
Dock (varieties, see DOCK).
Draining.
Drill.
Drum-curb.
Dualine.
Dumping-bucket.
Dynamite.
Earth-boring auger.
Earth-work.
Embankment.
Excavator.
Explorer.
Extension ladder.
False works.
Fascine.
Filling.
Finger-grip.
Fire-escape.
Fire-ladder.
Flood-gate.
Fulminate.
Gabion.
Gage-ladder.
Gavelock.
Girder.
Grab.
Grade.
Gradient.
Grading-post.
Grafting tool.
Grapnel.
Graving-dock.
Grillage.
Ground-mold.
Ground-plan.
Ground-plot.
Ground-work.
Grout.
Gulleting.
Gunpowder.
Half-lattice girder.
Horse power.
Horse run.
House moving.
Hydraulic engineering and devices.
Hydraulic mortar.
Inclined plane.
Jar. Boring.
Jetty.
Jumper.
Ladder.
Laminated rib.
Landing platform.
Lattice girder.
Lengthening rod.
Levee.
Level (varieties, see LEVEL).
Lewis.
Lift. Canal.
Lift-lock.
Lighthouse.
Lithofracteur.
Lock. Canal.
Macadamizing.
Masonry (see MASONS' AND BRICKLAYERS' TOOLS, etc.).
Metal.
Mill-dam.
Mining (varieties, see MINING).
Mole.
Monkey.
Mortar.
Nitrine.
Nitro-glycerine.
Nitroleum.
Notching.
Oil-well.
Pannier.
Paved way.
Pavement.
Paving.
Paving-machine.
Paving-roller.
Pebble paving.
Pick.
Pier.
Pierameter.
Pierre perdue.
Pile (varieties, see PILE).
Pile-drawer.
Pile-driver.
Pile-saw.
Pisé-work.
Pitched work.
Plank-road.
Polings.
Pozzuolana.
Praya.
Pricker.
Profile.
Propeller (varieties, see PROPELLER).
Pump (varieties, see PUMP).
Quadrel.
Quarrying-machine.
Rail (varieties, see RAIL).
Railroad (varieties, see RAILWAY-ENGINEERING).
Raising sunken vessels.
Ram.
Rammer.
Reamer.
Retaining wall.
Rising.
Road.
Road-making machine.
Road metal.
Road roller.
Road scraper.
Rock-crusher
Rock drill.
Roman cement.
Roofing composition.
Roofing machine.
Roof staging.
Roof truss.
Rounder.
Runner.
Saddle.
Sand scoop.
Sand pump.
Scaffold.
Scagliola.
Scarcement.
Scraper.
Screw-pile.
Sea wall.
Sewer.
Shield.
Shipwrighting (which see).
Shrinkage.
Side cutting.
Signal-tower.
Sinking.
Slackwater navigation.
Slating.
Slip.
Slope.
Sludger.
Snow-sweeper.
Spandrel.
Spoil.
Staging.
Staith.
Stall-boards.
Starling.
Steam-engine (which see).
Steining.
Stone. Artificial.
Street-railway.
Street-sprinkler.
Street-sweeper.
Street-watering.
Subterranean railway.
Sub-way.
Suspension bridge.
Suspension railway.
Swing bridge.
Talus.
Tamping.
Tamping-bar.
Tamping-plug.
Teaming.
Telo-dynamic cable.
Temoine.
Topit.
Torpedo for oil-wells.
Track-layer.
Traction engine.
Tramway for ferry-boats.
Tram-road.
Trass.
Trestle.
Truss.
Tube-extractor.
Tubular bridge.
Tunnel.
Tunnel-excavator.
Vault.
Vault-cover.
Vault-light.
Viaduct.
Water-elevator (which see).
Water-wheel (which see).
Well.
Well boring.
Well-drill.
Well packing.
Well-tubes, driven.
Well-tube filter.
Wharf.
Wing wall.
Wire way.

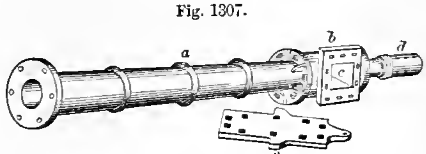
Clack. 1. (*Millwrighting.*) A device in grain-mills for ringing a bell when more grain is required to be fed to the hopper. A mill-hopper alarm.

2. A valve.

Clack-box. 1. In a locomotive, a ball-valve chamber attached to the boiler, and preventing the reflux of water in the feed-pipe.

2. The chamber of a clack-valve. The illustration shows the parts of a bucket-lift of a Cornish

Fig. 1307.



Clack Box and Door.

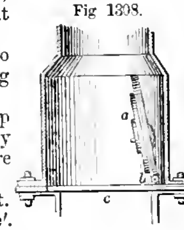
pump, lying upon the ground. It shows the working-barrel *a*, clack-box *b*, door *c*, and wind-bore.

Clack-door. (*Mining.*) The aperture through which the *clack* is fixed or removed.

Clack-mill. A noisy clapper urged by the wind, and intended to scare birds.

Clack-valve. A valve hinged at one edge, opened by the passing current, and clacking back on its seat by gravity.

Fig 1308.



Clack-Valve.

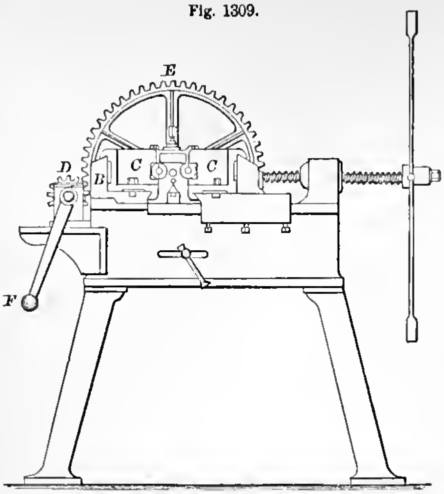
The butterfly-valve has two leaves hinged to a bar crossing the passage-way.

The valves of the feed-pump of a locomotive are technically called *clacks*, though they are frequently *ball*-valves.

a, valve; *b*, hinge; *d*, seat.

Clam'ming-ma-chine'. A machine in which an engraved and hardened *die* (*intaglio*) is made to rotate in contact with a soft steel *mill*, in order to deliver a cameo impression thereupon. The *mill* is used to indent copper rollers for calico printing. It

Fig. 1309.



Clamming-Machine.

is the same system as that used in the American bank-note engraving, and was invented by Jacob Perkins.

The mill is cylindrical, and is journaled in bearings attached to the headstock *B* of the machine. The cylindrical die is journaled in the sliding-piece *C*. The mill, having been adjusted in its bearings, is forcibly screwed up against the die, to which motion is imparted by the gears *D E* operated by the winch *F*.

Clamp. 1. A pile of bricks built up together in order to be burned.

2. (*Metallurgy.*) A pile of ore heaped for roasting, or of coal for coking.

3. (*Joinery.*) *a.* A frame with two tightening screws by which two portions of an article are tightly compressed together, either while being formed, or while their glue joint is drying. (*b*, Fig. 1310.)

b. A back batten inserted or attached crosswise to unite several boards and to keep them from warping. Otherwise called a *key*.

4. (*Shipbuilding.*) The internal planking of a ship under the *shelf* on which the ends of the deck-beams rest. In vessels of war, the *clamp* is the planking above the ports, and the *spirketing* that below the ports. See SPIRKETING.

5. (*Ordnance.*) One of the hinged plates over the trunnions of a gun, usually called *cap-squares*.

6. (*Machinery.*) One of a pair of movable checks of lead or copper covering the jaws of a vise, and enabling it to grasp without bruising.

7. (*Saddlery.*) See SEWING-CLAMP ; STITCHING-CLAMP.

For varieties of clamps, see under the following heads : —

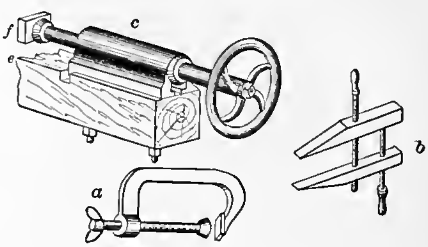
Axle-clamp.	Joiners' clamp.
Bench-clamp.	Lathing-clamp.
Book-clamp.	Line-clamp.
Castrating-clamp.	Molders' clamp.
Claw for suspending tackle.	Newspaper-clamp.
	Pipe-clamp.
Clutch.	Planking-clamp.
Flask-clamp.	Rigging-clamp.
Floor-clamp.	Rope-clamp.
Grinding-clamp.	Rope-clutch.
Harness-clamp.	Saw-clamp.
Hitching-clamp.	Sail-clutch.
Holdfast-clamp.	Screw-clamp.
Sewing-clamp.	Tourniquet.
Stitching-clamp.	Vise-clamp.
Stopper. Cable.	Weather-boarding clamp.
Strap-clamp.	

Clamp'er. A metallic shoe for a boot-heel, having calks to prevent slipping on ice. An *ice-creeper*.

Clamp-nail. (*Shipwrighting.*) A large kind of nail used to secure the clamps to the ribs of a ship.

Clamp-screw. A joiner's implement, on the bench, or to be attached to the work, for holding work to a table, or two pieces together.

Fig. 1310.



Clamp-Screw.

Clap'board. (*Carpentry.*) (Ger. *klapp-bord.*) A term irregularly used. It means : —

1. A weather-board on the side of a house, laid on, lapping the one beneath it, clinker fashion.

2. A roofing-board larger than a shingle and not usually shaved. A common size is a riven-board 48 inches long, and 8 inches broad. They are rived in the direction of the medullary rays, and the edge toward the heart is the thinner of the two.

3. In East England, a plank ; a cask-stave.

Machines are constructed for riving, sawing, planing, and gaging clapboards.

Clap'board-gage. A device used in putting on the weather-boarding of a house so as to leave a uniform width of face to the weather. The gage takes its set from the lower edge of the board last nailed on, and has a stop for the lower edge of the board next above.

Clap-net. A net in hinged sections which close upon the game.

Clap'per. A part which strikes, as : —

1. The tongue of a bell.

2. (*Mill.*) The clack which strikes the mill-hopper.

3. A piece of board to pat bricks to correct any warping when partially dried, in removing from the floor to the hack.

4. A clack-valve.

Clap'per-valve. (*Steam-engine.*) A valve suspended from a hinge and operating on two openings or seats alternately. In a modified form, it consists of a disk vibrating between two seats. A clack-valve.

Clap-sill. (*Hydraulic Engineering.*) The bottom part of the frame on which the lock-gates shut. The *miter-sill ; lock-sill.*

Clar'ence. A close single-seated carriage with a driver's seat in front.

Clar'i-bel'la. (*Music.*) A stop in an organ.

Clar'i-fi-ca'tion. The clearing of liquids by chemical means, as opposed to *filtration*.

Clarifiers or *finings* act by : —

1. Embracing the feculent matter and subsiding with it to the bottom of the vessel. Or : —

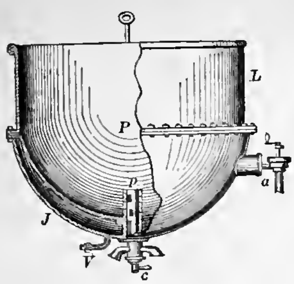
2. By inducing a change in the character of the liquid by which the feculencies are deposited as sediment.

The usual clarifiers are : —

Albumen, gelatine, acids, salts, blood, lime, plaster-of-paris, alum, heat, or alcohol.

Clar'i-fi-er. (*Sugar.*) A metallic vessel in which cane-juice is purified by heating and treatment with lime.

Fig. 1311.



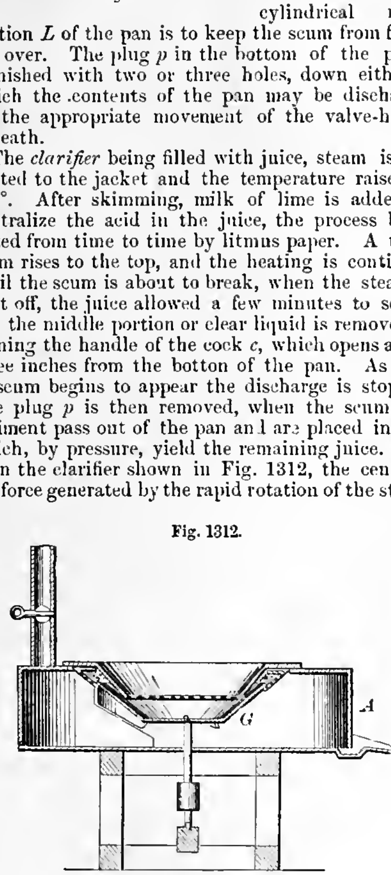
Clarifier.

It consists of a hemispherical copper pan *P* and a cast-iron jacket *J*, the intervening space being filled with steam by the pipe *V*. A pipe is used for conducting off condensed steam, and *a* is a faucet by which air escapes when the jacket is first charged with steam. The cylindrical upper portion *L* of the pan is to keep the scum from frothing over. The plug *p* in the bottom of the pan is furnished with two or three holes, down either of which the contents of the pan may be discharged by the appropriate movement of the valve-handle beneath.

The *clarifier* being filled with juice, steam is admitted to the jacket and the temperature raised to 174°. After skimming, milk of lime is added to neutralize the acid in the juice, the process being tested from time to time by litmus paper. A thick scum rises to the top, and the heating is continued until the scum is about to break, when the steam is shut off, the juice allowed a few minutes to settle, and the middle portion or clear liquid is removed by turning the handle of the cock *c*, which opens a hole three inches from the botton of the pan. As soon as scum begins to appear the discharge is stopped. The plug *p* is then removed, when the scum and sediment pass out of the pan and are placed in bags which, by pressure, yield the remaining juice.

In the clarifier shown in Fig. 1312, the centrifugal force generated by the rapid rotation of the strainer *G* causes the juice to flow up to and discharge through the perforations around its upper edge, whereby it is effectively brought in contact with the gas which pervades the curb *A*. The jets of juice are met by currents of gas, produced by the vanes.

Fig. 1312.



Centrifugal Clarifier.

Clar'i-fy-ing. The process of removing feculent matter from saccharine juices by heating, skimming, and precipitation. See CLARIFIER.

Clar-i-net'. (Ital. *clarinetto;* Fr. *clarinette.*) A reed instrument used in bands. Its name from *clarus* (Latin), clear, signifies a certain dominance of tone, and truly it emits an importunate sound. It is played by means of holes and keys, opened and closed by the fingers, after the manner of a flute. It was invented by John Denner in Leipsic, A. D. 1600. The double clarinet of the Arabs is termed a *zoomara.*

Clar'i-on. (*Music.*) *a.* A trumpet with a narrow tube, and having an acute and shrill tone. It was introduced by the Moors into Spain, A. D. 800.

b. A stop of an organ having metallic reed pipes tuned an octave higher than *trumpet;* in unison with *principal* and *flute.* See STOP.

Clasp. 1. A catch or fastening for a belt, the covers of a book, etc.

One part has generally a plate, which is bent over to form a hook, and the other has a wire on which the hook engages.

A belt-clasp is sometimes merely a hook and eye on the respective parts. See BELT-COUPLING.

2. (*Spinning.*) A device consisting of two horizontal beams, the upper one being pressed upon the lower one, or lifted, for drawing out the thread of cotton or wool.

3. A little bent plate which fastens two objects together, as the clasps which attach the wires to the tapes of hoop-skirts.

Clasp-hook. 1. A pair of hooks moving upon the same pivots, and forming mousings for each other.

2. A tongs, whose jaws *a* overlap upon each other. The running ring *b* is the *reins.*

Fig. 1313.

Clasp-Hook.

Clasp-knife. A large knife, the blade of which shuts into the handle.

Clasp-lock. A lock on the clasp which unites the two flaps of a book-cover.

Clasp-nail. A square-bodied, sharp, wrought nail, whose head has two pointed spurs that sink into the wood.

Clav'e-cin. (*Music.*) A harpsichord. A prostrate harp whose strings were agitated by plectra operated by keys.

Clav'i-chord. The *clavichord* was one of the predecessors of the *piano-forte.* Like the latter, the strings were *struck;* unlike the *harpsichord* and *spinet,* in which the strings were vibrated by a quill.

The string was struck by a vertical pin-wire, when the key was depressed. The sonorous vibration was modified by a *muffler,* consisting of a strip of cloth. This also gave a certain softness to the tone. The whole was enclosed in an oblong case. See PIANO-FORTE.

We read of a clavichord having forty-nine stops (keys ?) and seventy strings, which bore upon five bridges, the first being the highest, and the others diminishing in proportion.

The clavichord used in concerts about A. D. 1589 had been known for some centuries; it was a flat rectangular box having twenty keys, embracing two and a half octaves, the semitone *B* flat being introduced in addition to the seven tones of the diatonic scale. The instrument had no legs, and was supported on a table. It may be considered the precursor of the square piano. It is probable that there were not so many strings as keys, the strings being shortened, as in a guitar, by a device brought into action by the movement of the key, which struck the note.

We read in a Leipsic work of 1600 of an instrument brought by Prætorius from Italy to Saxony, in which each key had its own string. This was considered quite a novelty in a keyed instrument, though common enough in harps, and was not followed till long afterwards, probably the latter half of the eighteenth century.

Clav'i-cith-e'ri-um. (*Music.*) An old form of upright stringed instrument played by means of keys. It was used early in the sixteenth century, and has by some been supposed to be the same as the *virginal* (which see). The *clavicitherium* may be considered the precursor of the upright piano. It was modeled upon the *cithara*, and preserved a harp shape. It was comparatively light, and was rested on a table or the knees while playing.

Clav i-cym'bal. Prætorius, who wrote in the sixteenth century, describes a clavicymbal which he saw at Prague. It was the shape of a prostrate harp, or a grand piano without legs. Its compass was four octaves, with nineteen notes in each octave. The sharps and flats had separate keys; as, for instance, *c* sharp and *d* flat were separate with different tones; keys were also provided between *b* and *c* and *e* and *f*. *Clavicymbalum.*

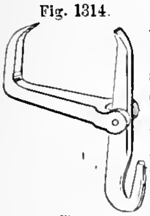
Cla'vi-er. (*Music.*) *a.* The key-board of an organ, piano-forte, or other instrument similarly played.

b. From Latin *clavis*, a key. The musical instrument of the sixteenth century, which consisted essentially of harps played by keys, were named from the latter feature CLAVICHORD; CLAVICYMBAL; CLAVICITHERIUM, etc. (which see).

Clav'i-ole. (*Music.*) A finger-keyed viol.

Claw. 1. (*Carpentry.*) *a.* A hammer with a bent and split peen to draw nails.

Fig. 1314.



Claw.

b. A little split tool for drawing tacks.

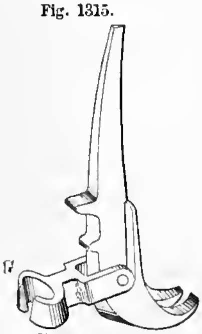
2. The bent and bifurcated end of a crow-bar; so also of the lifting-bar of a jack.

3. A bent hook on the end of a hoisting chain. A grapnel for suspending tackle. (Fig. 1314.) A hook-shaped tool.

4. (*Locksmithing.*) A spur or talon projecting from a bolt or tumbler.

The essential feature is the talon or hook, and the word forms a part of many compound words, as —

Fig. 1315.

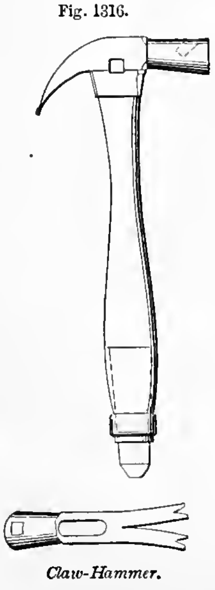


Claw-Bar.

Claw-bar.
Claw-hammer.
Claw-jack.
Claw-wrench.
Rail-claw.
Tack-claw, etc.

Claw-bar. A lever or crow-bar with a bent bifurcated claw for drawing spikes. The cut shows a supplementary shackle *G*, for reaching the heads of spikes in deep-seated depressions.

Fig. 1316.



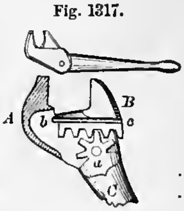
Claw-Hammer.

Claw-ham'mer. A hammer having a bifurcated bent peen, suitable for catching below the head of a nail to draw it.

Claw'ker. (*Knitting-machine.*) A feed-pawl or hand for a ratchet.

Claw-wrench. A wrench having a loose, pivoted jaw which binds of itself.

Fig. 1317.



Claw-Wrench.

Such are many of the forms of *pipe-wrenches* (which see).

In the one shown, the jaw *B* is made to approach jaw *A* by the engagement of the circular rack *a* on the handle with the rack *c* on the jaw *B*, so that the harder the strain on the handle the tighter the pinch.

Clay. A composition of silex or flint, mixed with alumina. The latter is usually about one fourth.

Porcelain clay is formed by the decomposition of a rock formed of quartz and feldspar.

Chinese *kaolin* consists of — silex, 71.15; alumina, 15.86; lime, 1.92; water, 6.73.

Cornish kaolin consists of — silex, 50; alumina, 50; lime, 1.

In the common acceptation of the term, clay is an earth which possesses sufficient ductility and cohesion, when kneaded with water, to form a paste and permit being fashioned by the hand, in a mold, or on a lathe.

Clayes. (*Fortification.*) Hurdles to form blinds for working parties. Reinforced with earth, they are substantially *gabions*, and as such are of a more permanent character.

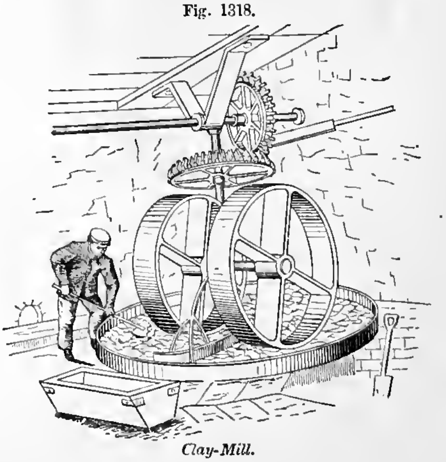
Clay'ing. 1. (*Sugar-making.*) A process in the crystallization of refined sugar in molds, in which a lump of wet clay is laid upon the base of the inverted cone of wet sugar, to secure the more perfect drainage of the coloring solution therefrom, by the prolongation of the process.

2. (*Mining.*) Lining the blast-hole with clay, to prevent the explosive becoming damp.

Clay'ing-bar. (*Mining.*) A cylindrical bar for driving tenacious clay into the crevices of a blast-hole, in order to prevent percolation of water on to the charge.

Clay-mill. A mill for grinding clay for bricks,

Fig. 1318.



Clay-Mill.

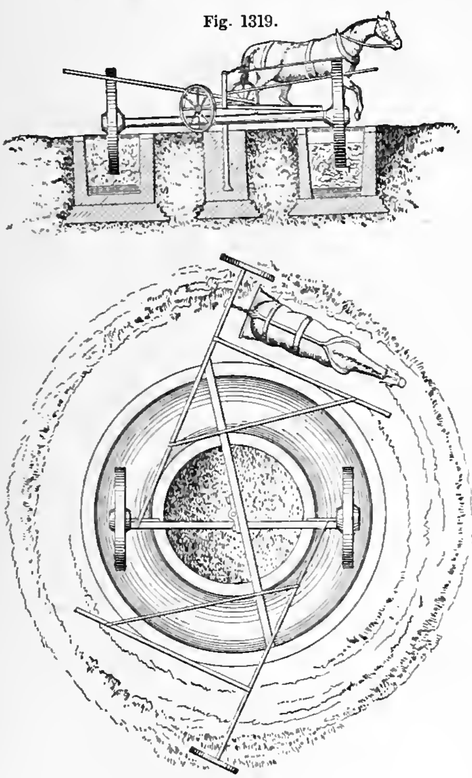
tiles, or the manufacture of pottery, stone-ware, porcelain, etc. The pug-mill is the form most usually employed. See BRICK-MACHINE; PUG-MILL.

In the South of England, at a famous clay-pit which supplies the potteries of London and Staffordshire, a form of Chilian mill is used. The dry clay is shoveled into a pan, which has a grated bottom; the runners rub and squeeze the clay so as to render it homogeneous, and mix thoroughly the clayey with the sandy particles with which it abounds.

To the upright shaft of the runners are attached two scrapers projecting as far as the rim of the bed-plate; the one is continually spreading the clay over the gratings, to allow the fine clay to pass through; and the other follows, collecting the coarser particles, and is so placed as to bring them again under the runners.

Another kind of mill may be used for working clay into mortar for bricks. It is used in England

Fig. 1319.



Clay-Mill.

for grinding chalk into pulp for adding to the kinds of clay deficient in lime, and is called a *crashing-mill.* Two of these mills are placed close together on a large double mound, sufficiently elevated to allow the *malm* to run down freely to the brick-earth. The chalk-mill is a circular trough lined with brickwork, in which the chalk is ground by the action of two heavy wheels with spiked tires, made to revolve by either one or two horses. The trough is supplied with water by a pump, the lever of which is worked by the machinery of the clay-mill, and as the chalk becomes ground into pulp it passes by a channel to the brick-earth with which it is incorporated in a pug-mill.

Clay′more. Formerly the two-handled sword of the Scotch Highlanders. Now a basket-hilted broadsword.

Clay-pipe. See TOBACCO-PIPE.

Clay-proc′ess. In this process clay is substituted for plaster in the process of making stereotype molds. The face of the type is forced into the clay by pressure. A plaster-mold, on the other hand, is formed by pouring the plaster on the type.

Clay-pul′ver-iz-er. A machine for grinding dry clay to render it more homogeneous previous to pugging.

Clay-screen′ing Ma-chine′. A machine for sifting pulverized clay. Used in preparing it for some of the finer ceramic manufactures.

Cleach′ing-net. A hand-net with hoop and pole.

Clead′ing. Plank covering or casing. As:

1. (*Mining.*) The boarding which lines a shaft or a tunnel.

2. (*Hydraulic Engineering.*) *a.* The planking of a dam or coffer-dam; or of a sea-wall, secured to guide piles, for instance.

b. The planking or skin of a canal lock-gate.

3. (*Steam-engine.*) The wooden covering of a steam-boiler or cylinder to prevent the radiation of heat. *Lagging.*

Clean′er 1. (*Leather.*) A currier's straight, two-handled knife, with a blade two inches broad.

2. (*Founding.*) A *slicker.* A tool used for smoothing surfaces in sand-molding.

3. (*Carding.*) One of a pair of small card cylinders called *urchins*, arranged around the periphery of a card-drum. The *worker* is the larger of the two; it takes the fiber from the card-drum and delivers it to the *cleaner*, which returns it to the card-drum. See CARDING-MACHINE.

Clean′ing-ma-chine′. (*Silk-manufacture.*) A machine in which silk thread is carried from bobbins over a glass or iron guide-rod, and then drawn through a brush in order to detach any particles of dust or dirt therefrom. To remove knots or bunches the thread is drawn through a notch in a bar of metal. When a knot refuses to pass through the opening, the plate is depressed, the bobbin lifted off the friction-roller which drives it, and, the attention of the operator being thus drawn to it, the knot or fluff is picked off and the bobbin again set in motion. See also COTTON-CLEANER.

Cleans′ing-vat. (*Brewing.*) A vessel in which the fermentation of beer is concluded; the yeast running out of the bung-hole, and being kept full by supply from a store-vat.

Clear′ance. (*Steam-engine.*) The distance between the piston and the cylinder-head when the former is at the end of its stroke.

Clear-cole. (*Painting.*) (From *clairè colle*, transparent size.) A priming coat prepared with size instead of oil.

In *oil-gilding*, a coat of clear-cole is laid on intermediate between the *white stuff* and the *oil gold-size.* See GILDING.

Cleare. The filtered fluid of coarse sugar decolorized by bone-black.

Clear′er. 1. A tool on which the hemp for sail-makers' twine is finished.

2. A rapidly revolving roller in the scribbling-machine laid alongside the *worker.*

Clear′er-bar. A bar in a horse hay-fork which throws the hay out from the teeth when the rake is lifted.

Clear-foun-da′tion Lace. Also called Lisle lace, from the French town of that name. A light, fine, transparent, white thread, hand-made lace. It has a diamond-shaped mesh formed by two threads plaited to a perpendicular line.

Clear'ing. 1. (*Silk-manufacture.*) The process of removing irregularities from silk filaments before spinning, by passing them beneath a scraper, or between steel rollers. See SILK-MANUFACTURE.

2. (*Calico-printing.*) Washing the dye solution from the unmordanted portion of the cloth, in the "madder style" of printing.

3. (*Machinery.*) The amount of play between the meshing-teeth of cog-wheels, to avoid jam.

Clear'ing-beck. (*Dyeing.*) A vat in which cottons printed with certain colors are scoured with soap and water.

Clear'ing-pan. (*Sugar-manufacture.*) A CLARIFIER (which see).

Clear'ing-screw. In some fire-arms, a screw at right angles to the nipple, affording a communication with the chamber.

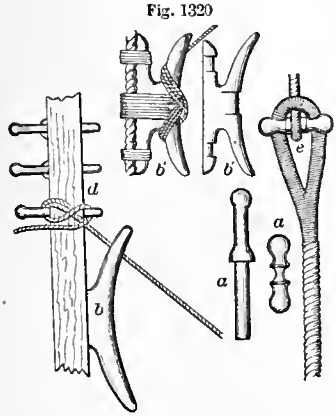
Clear'ing-stone. The fine stone on which the currier's knife receives its final whetting. It is first ground on the *rub-stone.* The knife has its edge turned over by a steel.

Clear-stuff. Boards free from knots, wane, wind-shakes, ring-hearts, dote, sap.

Cleat. (*Carpentry.*) 1. A strip of wood secured to another to strengthen it; as a batten placed transversely on the back of several boards which are jointed or matched together.

2. (*Nautical.*) A belaying piece, consisting of a bar with two arms fastened to a post or stanchion by a bolt passing through its stem.

Fig. 1320



Cleats.

a a, belaying-pins.
b, cleat.
b' b'. cleats lashed to a stay.
d, belayed rope.
e, belaying-pin splice.

3. An iron nailed to a shoe-sole to preserve it.

4. A trunnion bracket on a gun-carriage.

Cleav'er. A heavy, long-bitted chopping-tool, used by butchers in cutting up carcasses. In the pork-packing establishments of Cincinnati, Chicago, etc., it is used to the exclusion of other cutting tools, except in trimming. Two men with cleavers stand on each side of the block. One cut severs the head from the body; another severs the body at the loins, cutting off both hams; the third chops off the two hind feet; the fourth removes the two fore feet; a fifth divides the hams; two or three divide the middles and shoulders on the line of the backbone. It is more quickly done than told. Circular saws are now substituted in some establishments.

Cleav'ing-knife. (*Coopering.*) A tool used for riving jaggles into staves, clapboards. A *frow.*

Cleav'ing-saw. A *pit*-saw; a *rip*-saw, as distinguished from a *cross-cut* saw.

Clench-bolt. One whose pointed end is clenched after passing through the wood, — sometimes over a washer or ring.

Clep'sy-dra. A *water-clock; a hydroscope.* The invention of the clepsydra was ascribed by the ancient Egyptians to *Thoth*, who is held to be the original Mercury. It was in use among the Egyptians, Chaldeans, Greeks, and Romans.

The name is derived from the simple form of a basin with a small hole in the bottom, which, being placed in a vessel of water, gradually filled and sank. This plan is said to be still used in India, and marks a time equal to about twenty minutes, called a *gurhee.* An Indian *clepsydra* of a different construction is mentioned in the arithmetical treatise of Bhas-cara, written in the twelfth century.

The clepsydra is thus described in the Sûrya-Siddhanta, a Sanscrit text-book on astronomy: — "A copper vessel, with a hole in the bottom, set in a basin of pure water, sinks sixty times in a day and night, and is an accurate hemispherical instrument." — Ch. xiii., s. 23.

The Chaldean astronomers used clepsydras as measurers of time, and they remained as accessories to astronomical observatories down to the time of Galileo.

The Chaldeans divided the zodiac into twelve equal parts by allowing water to run out of a small orifice during the whole revolution of a star, and dividing the liquid thus obtained into twelve parts. So says Sextus Empiricus. It is probable that the discharging-vessel was kept at a constant level, or otherwise equal quantities passing would mark unequal times as the pressure diminished. If the vessel were kept constantly full, it would discharge a quantity equal to its capacity in half the time it would empty itself unrenewed.

Athenæus, a distinguished Greek writer of the third century, A. D., a native of Egypt, in the course of his "table-talk" mentions that Plato (372 B. C.) had constructed a clepsydra or water-dial which played upon pipes the hours of the night, at a time when they could not be seen on the index.

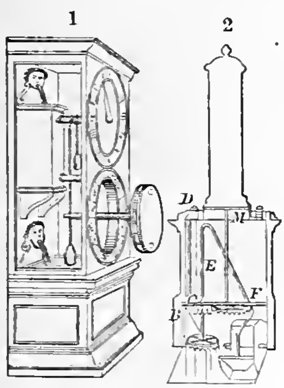
Vitruvius dates the invention something over 100 years later, attributes it to Ctesibus of Alexandria, who lived under Ptolemy Euergetes, 245 B. C., and who states that water was made to drop upon wheels which turned and actuated a small statue having a stick in his hand. The figure rotated on its pedestal and pointed to the figures on a numbered circle. They were, however, known before Ctesibus, but it is probable that he applied toothed wheels to them. They were introduced into Rome by P. Cornelius Scipio Nasica, 157 B. C. The orators in Rome, in the time of Pompey, were limited to a certain time: as Cicero says, *latrare ad clepsydram.* It is supposed that among the Romans they consisted of a vessel from which the water issued drop by drop, falling into another vessel in which a rising float indicated against a graduated index the lapse of time.

It may be that they used the *hour-glass*, a modified form of the *clepsydra*, sand being substituted for water, and under a gag or five-minute rule, the running out of the sand shut up the mouth of an orator who was disagreeable to the majority. The friends of Cataline, we may suppose, failed to enforce the rule against Cicero, whose friends moved for a suspension of the rules, and so we have *Quousque tandem abutere*, etc., the delight of compositors, and the horror of dull school-boys.

In the instrument of Ctesibus, 2, 3, Fig. 1321, the device for the measurement of the hours was a cylinder resting upon a pedestal; two figures were placed upon the latter, one of which dropped water from its eyes, while the other pointed with a wand to the hour marked on a vertical line drawn upon the cylinder. This cylinder turned on its axis once a year, and on it were drawn curved lines which exhibited the inequality of the hours on different days, by their being marked at unequal distances.

The manner of working this machine was to allow the water to rise through a tube, which, passing through one figure, was discharged into a reservoir *M*, from which it passed into the pipe *B C D*. In this pipe a piece of wood floated upon the surface, and by its ascent, as the pipe filled, it raised the small pillar *C D*, on which the other figure rested, and as the float rose in the pipe the wand was made to point to the different hours. Every twenty-four hours the vessel became filled, as did the inverted siphon, which communicated with it. The water was then drawn off by the siphon, *E F*, and falling in its descent into the buckets of the wheel below, put that in motion. This wheel had six buckets, and therefore made one revolution every six days. Its axis carried a pinion of six teeth, working on another wheel of sixty teeth; this also carried another pinion of ten teeth, and drove a wheel of sixty-one teeth, which by its axis turned the pillar round once in 366 days. These machines indicate

Fig. 1321.



Clepsydras.

considerable hydrodynamical knowledge, and suggest some acquaintance of Ctesibus with Archimedes, who traveled in Egypt.

In the clepsydra shown at 1, Fig. 1321, the water from an upper reservoir, kept constantly full, passed through a pipe into a drum having apertures of various sizes corresponding to the length of the days at different seasons of the year. The flow was regulated by turning the drum so that its index should correspond with the proper division of a zodiac engraved on the face of the clepsydra. The water was discharged into a lower reservoir, on which floated an inverted vessel suspended from a chain passing around an axis upon which the hour-hand was fixed and counterbalanced. As the water rose, the vessel ascended, turning the hand on its axis and indicating the hour on a dial.

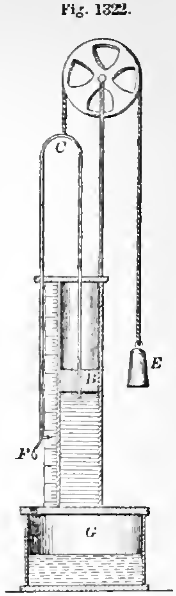
Clepsydras are said to have been found in use among the Britons by Julius Cæsar, 55 B. C.

The Saracens had several kinds of clepsydras; one with a balance.

A clock was presented by Pope Paul I. to Pepin, King of France, A. D. 760; was possibly a clepsydra. Pacificus, Archdeacon of Genoa, invented one in the ninth century.

Lately, the clepsydra has been adapted by Captain Kater, for the accurate measurement of short intervals of time, by the flowing of mercury from a small orifice in the bottom of a vessel, kept constantly filled to a certain hight. The stream is intercepted at the moment of noting any event, and diverted aside into a receiver, into which it continues to run till the moment of noting another event, when the intercepting cause is suddenly removed and the stream turned to its original channel. The weight of mercury in the receiver in comparison with the known rate of passage determines the interval between the events.

Fig. 1322.



Clepsydra.

Professor Airy, Astronomer Royal of England, has applied the clepsydra to communicating motion to telescopes equatorially mounted.

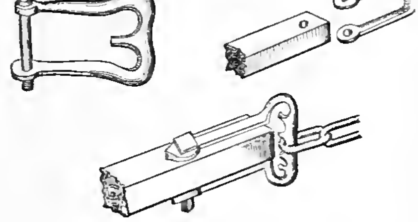
Partington's clepsydra is constructed to discharge equal quantities of water in equal times. *B* is a float on the surface of the water, and *E* is a weight to counterbalance the weight of the siphon *C*, and its contained water. The water is discharged at *F*, the lower end of the long leg of the siphon, and is collected in the box *G*, which forms the base of the instrument.

The Chinese clepsydras are described in the United States Agricultural Report, 1851, plate at the end of the book. The description in the Mechanical Report of the Patent Office, same year, pp. 335, *et seq.*

Clere-sto′ry. That upper portion of the middle aisle of a Norman or Gothic cathedral church which shows above its side aisles, and has a tier or row of windows on each side looking clear over the side-aisle roof. A *clear-story*.

Cle′vis. A stirrup-shaped metallic strap, used

Fig. 1323.



Clevis.

in connection with a pin to connect a draft-chain or *tree* to a plow or other tool.

The illustration shows several forms for vertical and horizontal adjustment, for plows, double-trees, shovel-plows, etc.

Clew. (*Nautical.*) *a.* A lower corner of a square-sail; the aftmost corner of a fore-and-aft sail. The *clewlines* are attached to the clews of a square-sail, and draw the latter up to the yard in furling. The *sheets* are attached to the same corners, and expand the sail.

b. The lines fastened to the ends of a hammock and meeting at the *grommets*, to which are attached the lanyards by which the hammock is suspended from rings or hooks in the deck-beams.

Clew-gar′net. (*Nautical.*) A tackle attached to the clew of a lower square-sail, to haul it up to the yard in furling.

Clew-gar′net Block. (*Nautical.*) A block with a single sheave, and strapped with two eyes, which are lashed together above the yard.

Fig. 1324.

Clew-Garnet Block.

When double, the foremost sheave is for the top-gallant clewline and the after one for the royal sheet. The leading part of the fall follows down the mast to the deck.

Clew′line. (*Nautical.*) A rope for hauling up the clew of an upper square-sail.

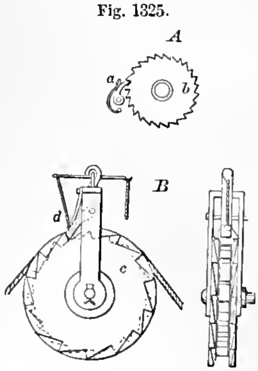
Cliché. (*Printing.*) *a.* The process of obtaining a matrix or cast *in intaglio* from a form of type, so that a cast in metal in cameo may be obtained therefrom for printing purposes. The usual material for newspaper work is papier-maché, or paper in sheets. When the latter material is used, it is dampened and laid upon the form, the thickness of paper, number of sheets, and degree of dampness, being a matter of experience and skill. A stiff brush is then dabbed over the surface in such a manner as to force down the paper between the type, so as to obtain a perfect mold. This is then dried, backed to give it the necessary rigidity, and forms a mold on which a stereotype-plate is cast.

b. A mode of obtaining an impression from a die in high relief, or from a form of type, by striking the cold die with a sudden blow upon a body of metal which is just becoming solid.

Click. The detent *a*, of a ratchet-wheel *b* (Fig. 1325), falling into the spaces between the cogs as the wheel revolves in one direction, and preventing the backward motion of the wheel. The name is no doubt derived from the sound. It usually acts by spring, sometimes by gravitation. In larger machines it becomes a *pawl*, as in the capstan.

Click-pul′ley. The rim of the sheave *c* (Fig. 1325, *B*) has notches, engaged by a spring click *d*, which acts as a detent to restrain the sheave from running back. The groove of the sheave is toothed to prevent the slipping of the rope therein. The click is raised by a trigger and cord when required.

Fig. 1325.



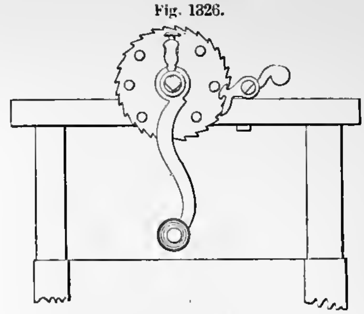
Click and Click-Pulley.

Click′et. A latch-key; the latch of a door.

Click-wheel. A wheel whose cogs are radial on one face and inclined on the other, so as to give a square face to the end of the *click, pawl, ratchet*, or *detent*, which prevents the back movement of the wheel. A ratchet-wheel.

Climb′er. 1. (*Telegraphy.*) A boot provided

Fig. 1326.



Click and Click-Wheel.

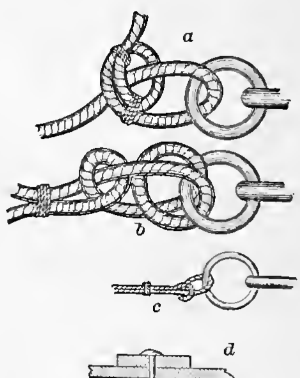
with spurs, by which a person is enabled to climb telegraph-poles to make repairs or additions to the wires or insulators.

2. (*Railroad Engineering.*) A driving-wheel of a locomotive, having a positive grip, as by cogs or pinchers, upon a rail or rack in ascending or descending grades.

Clinch. 1. (*Nautical.*) A mode of fastening large ropes, consisting of a half-hitch with the end stopped back to its part by seizings. The *outer end* of a *hawser* is *bent* by a *clinch* to the *ring* of the *anchor*.

a, slip-clinch.
b, clinch secured.
c, simple clinch.

Fig. 1327



Clinch.

The knot of the breeching, which secures the gun to the ring-bolts on the side of the gun-port.

2. A fastening, *d* (Fig. 1327), in which the long end of a nail is turned over and the recurved end caused to enter the material so as to oppose retraction.

Clinching is distinguished from *riveting*, as the metal in the latter process is swaged down either against the object or upon a washer.

3. (*Farriery.*) The turning over and beating down of the end of a horseshoe nail, against the wall of the hoof, to prevent retraction.

Clinch-built. See Clincher-work.

Clinch′er. A tool for clinching, — that is, turning over the pointed end of a nail so as to prevent its retraction.

In wood, the end is bowed over and driven into the piece through which the nail last passed.

In farriery, the end of the horseshoe nail is nipped off and the stub battered down so as to oppose a hooked, flattened portion, against the action of withdrawal. After the nail has been driven by a hammer in the ordinary way, one jaw is placed upon the head of the nail, and the other jaw is brought up to engage with and flatten down the point of the nail.

Clinch′er-built. See Clincher-work.

Clinch′er-work. 1. *Lap-jointed* work. A mode of building in which the lower edge of each plank overlaps the one next below it, like the weather-boarding of a house; the shingles or slates of a roof.

The term is variously compounded: *Clincher-build, clincher-plating, clincher-work,* and, erroneously, *clinker-work.*

The root of the word *clinch* is to grasp or fasten, and the feature of the joint is a lap or fold. *Clink* is an onomatopoetic word derived from the sharp sound of a vitreous body when struck; hence *clinker.*

Clincher-work is used on boats of a lighter description, — the galley, gig, cutter, jolly-boat, dingy, etc. (See BOAT.) The lower edge of each strake of plank overlaps the upper edge of the next strake below. They are not built upon frames, but upon temporary transverse sectional molds, two, three, and four in number, which are fixed at their proper stations on the keel. The strakes are then put on, beginning with the garboard strake, and bent to the figure given by the molds. Each strake is fastened to the next below it by nails, driven from the outside through the laps or *lands.*

When two or more lengths of plank occur in a strake, they are scarfed to each other, the outside lap of each scarf pointing aft. The scarfs have a layer of tarred paper between, and are fastened with nails driven from the thin end of each piece.

2. A mode of uniting the iron plates of vessels, tanks, or boilers, in which the edges are *lapped,* and secured by one row of rivets. It is distinguished from *carvel*-build, in the respect that in the latter the edges of the plates are brought together and the joint covered by an interior *lap* or *welt,* to which the plates are secured by two rows of rivets, one to each plate.

Clinch'ing. (*Nautical.*) Slightly calking the seams round the ports with oakum, in anticipation of foul weather.

Clinch'ing-iron. See CLINCHER.

Clinch-joint. See CLINCHER-WORK.

Clinch-ring. A lap-ring or open ring, in which the parts on the sides of the opening overlap each other.

Clin'i-cal Ther-mom'e-ter. (*Surgical.*) A thermometer with a long bulb on a bent arm. The straight portion only is attached to the index-plate, which has a range from 80° to 120°. In use, the bulb is inserted in the axilla, or the mouth. The instrument is self-registering, and is graduated to fifths of degrees.

Clink'er. 1. A brick whose surface is vitrified by the extreme heat of the fire.

2. A description of Dutch brick.

3. A scale of oxide of iron formed in forging.

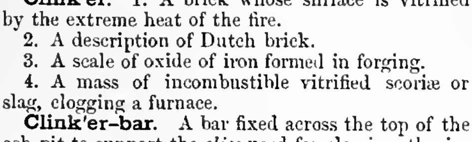
4. A mass of incombustible vitrified scoriæ or slag, clogging a furnace.

Clink'er-bar. A bar fixed across the top of the ash-pit to support the *slice* used for clearing the interstices of the bars.

Clink'er-built. See CLINCHER-WORK.

Cli-nom'e-ter. 1. An instrument used in determining the slope of cuttings and embankments. It has a quadrant graduated to degrees and fixed at

Fig. 1328.



Clinometer and Level.

the end of a long bar which is laid adown the slope; an index turns upon the center of the quadrant, to which a spirit level is attached. The level being set horizontally, the angle of the same will be indicated on the quadrant as the latter partakes of the motion of the rod. A *batter-level.*

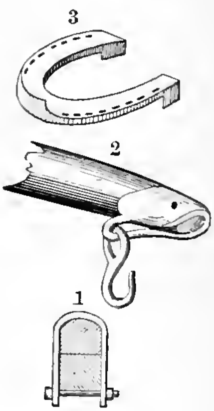
2. A carpenter's tool for leveling up sills and other horizontal framing timbers.

That illustrated is a combined clinometer, plumb, and level, and has a vertical circular box, with an arrangement of scales so graduated as to give, in connection with one or more index fingers, the amount of deflection of an object from a vertical or horizontal position, in both circular and linear measurement.

Clin'quant. A meretricious alloy; yellow copper; Dutch-gold. See ALLOY.

Clip. 1. An embracing-strap to connect parts together, as in the case of *clips* on the axle which connect the springs thereto.

Fig. 1329.



Clips.

The wheels of the ancient Egyptian chariots had strengthening clips of bronze at the junction of the spokes and fellies. The wheels were of small diameter, and not of very strong construction. Metal was sparingly used.

2. An iron strap on a double or single tree, with a loop by which either is connected to the plow-clevis, the trees to each other, or the traces to the single tree.

3. A projecting flange on the upper surface of a horseshoe which partially embraces the wall of the hoof.

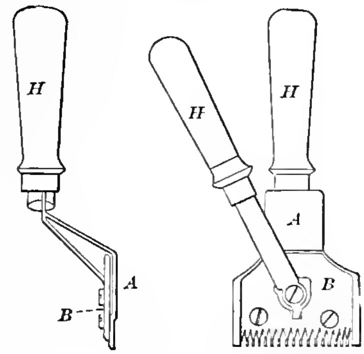
Clip'per. 1. (*Nautical.*) A fast-sailing vessel, constructed on fine, sharp lines; built especially for speed rather than cargo.

2. A machine for clipping hair. It is especially used for horses, and in England more than in any other country. One form has a stationary knife and several spiral knives on an axis, acting against the edge of the former. A comb is so arranged as to determine the length to which the hair is cut.

A more usual form has a serrated knife reciprocating shearwise, with a similar plate, stationary, or also reciprocating.

Clip'ping-shears. Shears for clipping horses,

Fig. 1330.



Clipping-Shears

having a guard which gages the length of hair remaining. One form is shown in Fig. 1330, in which the serrated knife *B* is reciprocated above the serrated plate *A* by means of the handle *H*, the hairs which come between the teeth being severed thereby. A number of cutters are so arranged on a comb that the length of hair left, in clipping, may be regulated, and the cutters are guarded by said comb so that the skin of the animal cannot be injured.

Clip-plate. (*Carriage.*) The axle-band of a wheel.

Clis'e-om'e-ter. (*Surgical.*) An instrument for measuring the angle which the axis of the female pelvis makes with that of the body.

Clives. A hook, with a spring to prevent its unfastening.

Clo-a'ca. A sewer. The word is Latin, and has been long celebrated in reference to the *Cloca Maxima*, the main sewer of ancient Rome, constructed by the Tarquins, and yet serviceable.

Clock. An instrument, — differing from a watch in not being adapted to be carried on the person, — and having a motive weight or spring, a train of gearing, index-hands, and figured dial, and a pulsative device to determine the rate at which the mechanism shall move.

Before the invention of mechanism by which a rate of motion of a staff or pointer was made to indicate periodic lapse of time, the shadow of the sun in his apparent daily progress enabled the observation of the passing hours. A gnomon, erected so as to throw its traveling shadow across a graduated arc, constitutes a dial, though many considerations intervene between the mere post-shadow which cuts the mark upon the sand, and the dial whose readings will suit the varying circumstances of the earth in its solar relations at the solstices and the equinoxes. See DIAL.

First the dial and then the clepsydra, is the apparent order; the latter is a mechanical time-indicator (see CLEPSYDRA), but not a clock, if the meaning of the latter term — to strike, to beat — is to constitute the distinction; the *cluck-cluck* of a hen, and the *click-click* of a ratchet-wheel, are the lingual allies of the *clock*, whose pendulum gives the rate of the tick-tick made by the contact of the scape-wheel teeth with the pallets.

The graduated face-plate with figures belonged to the *dial* long before the time of *clocks*, which are audible in their very name and nature, and the name *dial* is now very properly applied to the face of a clock or watch, as their duties are (Latin, *dialis*) daily. We have no record that goes back of the division of the circle into degrees, and the early dials were thus divided. Perhaps the vigesimoquartal division of the dial was derived from the Chinese, for their compass had many centuries ago a number of divisions representing the cardinal and intermediate points, and also certain divisions of the natural day. The division of the Chinese compass into twenty-four points, marking periods of the natural day equal to 15° of the circle, was probably derived from the supposed number of days ($24 \times 15 = 360$) occupied by the sun in its (apparent) course through the heavens. See DIAL.

Most nations, we may suppose, had some definite mode of marking divisions of diurnal time; with the Jews the time between sunrise and sunset was divided into twelve periods, which were therefore longer at the summer solstice than at equinoxes, and longer at the latter than at the winter solstice. This complicated the construction of "the dial of Ahaz" referred to by Hezekiah, and which was probably brought from Damascus by Ahaz; we know that he obtained the pattern of an altar from thence. We read (Daniel iv. 19) that Daniel "was astonished for one hour," Chaldean time, which is not astonishing, considering the critical nature of the message he had to deliver. Distinct intimation of the hours is given in connection with the setting up of the dial in the Quirinus at Rome, 293 B. C. The hours were called through Rome by public criers, as they were at night by watchmen, within the memory of some of us.

"They return at evening; they make a noise like a dog, and go round about the city." — Psalms lix. 6.

Clocks are not very common in China, being mostly confined to the public offices, where it is common to find half a dozen all in a row.

The Chinese divide the day into twelve parts of two hours each. The Italians reckon the twenty-four hours round, instead of dividing them into two sections of twelve hours each, as we do. The Mexican day was divided into sixteen hours or periods.

The early expedient in England was wax tapers, invented by Alfred the Great, A. D. 886. It appears that even hour-glasses were not then known in England, though they are regarded as very ancient, and were certainly known in Rome long previously.

The first "striking" or audible notification of the hour, on record, is the clepsydra or water-dial of Plato, 372 B. C., which, by the agency of water, sounded upon organ-pipes the hour of the night when the index could not be seen. The contrivance is mentioned by Athenæus of Egypt, a distinguished Greek writer of the third century, and author of the "Deipnosophistæ." See CLEPSYDRA.

Wheel-work set in motion by springs and weights was known in the time of Archimedes (287 - 212 B. C.), and applied to mechanical engines and toys.

The graduated dial, the shadow of the gnomon marking hours, was known in Rome 293 B. C.

Two more things were necessary to make a clock: —

1. To join the wheels to a pointer which traversed the dial.
2. To contrive a mode of regulating the speed of the going works.

When these two features were united to form a clock is not known.

The early indications are as follows: —

A. D. 760, a clock presented by Pope Paul I. to Pepin, of France: probably a clepsydra.

A. D. 810, the clock sent by the Khalif Haroun al Raschid to Charlemagne is believed to have had some kind of wheel-work, but to have been impelled by the fall of water. In the dial were twelve small doors forming the divisions for the hours, each door opened at the hour marked by the index, and let out small brass balls, which, falling on a bell, struck the hours. The doors continued open until the hour of twelve, when twelve figures, representing warriors on horseback, came out and paraded around the dial-plate.

Pacificus, Archdeacon of Verona, seems to have improved the clock.

A. D. 1000, Ebu Junis, of the University of Cordova, had a *pendulum*-clock; to which Gerbert is supposed to have added the *escapement*. See PENDULUM.

The balance clock described by Al Khâzinî, twelfth century, consisted of a beam suspended on an axis a little above its center of gravity, and having attached to one of its arms a reservoir which, by means of a perforation in its bottom, emptied itself in twenty-four hours. The reservoir was poised by other weights which slipped down their arm as the discharge of water lightened the other arm, and the place of the weights marked the lapse of time.

Where the period of the clepsydra terminated, and that of weight-driven clocks commenced, cannot now be determined, but it is certain that the clocks of the Spanish Saracens were driven by weights. The renowned Gerbert studied philosophy and common-sense at the Saracenic University of Cordova, became successively a schoolmaster at Rheims (where he had a clock), Archbishop of Ravenna, and Pope Sylvester II., to which latter dignity he was advanced by the Emperor Otho III.; and they died by poison, both of them.

To follow up the recital: —

A. D. 1288, a clock was placed in the old palace yard, London, and remained till the reign of Queen Elizabeth.

A. D. 1292, a clock was placed in Canterbury Cathedral.

A. D. 1300, Dante refers to a clock which struck the hours. Chaucer refers to the *horologe*.

No certain mention is made, up to this time, of the means of regulating the speed of the machine, and that the pendulum had not been adopted to any extent, is certain.

It may be presumed that the device used was a *fly* (see FLY); a wheel with vanes which impinged upon the air, the latter affording a resistance proportioned to the size, number, radius, angle, and speed of the vanes. Such was the case probably with: —

A. D. 1380, the clock erected by Richard of Wallingford, abbot of St. Albans.

During the same century a pulsating regulator was introduced into France.

A. D. 1364, Henry de Wyck, or de Vick, a German, erected a clock in a tower of the palace of Charles V., at Paris.

A. D. 1368, a striking clock was erected at Westminster.

A. D. 1370, clocks at Strasburg and Courtray, after which they became quite common.

The pulsating arrangement of Henry de Wyck consisted of an alternating balance, which was formed by suspending two heavy weights from a horizontal bar fixed at right angles to an upright arbor, and the movement was accelerated or retarded by diminishing or increasing the distance of the weights from the arbor.

This clock, which had no regulating spring, was the type of the astronomical clocks used by Tycho Brahe (1582), and by many less illustrous but worthy and useful observers, at and about the same date.

Clocks were in possession of private persons about 1500, and about the same time watches were introduced.

Shakespeare refers to a watch in the play of *Twelfth Night*, where Malvolio says: — "I frown the while, and perchance wind up my watch, or play with some rich jewel."

"Mr. Pierce showed me the Queene's [the Portuguese princess, wife of Charles II.] bedchamber, and her holy-water at her head as she sleeps, with a clock by her bedside, wherein a lamp burns that tells her the time of the night at any time." — *Pepys's Diary*, 1664.

The pendulum, which engaged the attention of the Spanish Saracens in the eleventh century, and persons of other nations who were so fortunate as to visit their University of Cordova, had a sleep of six centuries, for it was reserved for the seventeenth century to bring it into general notice and usefulness.

Early in the seventeenth century, Galileo, observing the oscillations of a suspended lamp, conceived the idea of making a pendulum a measurer of time, and in 1639 published a work on mechanics and motion, in which he discussed the isochronal properties of oscillating bodies suspended by strings of the same length.

A. D. 1641, Richard Harris constructed a pendulum clock in London, for the church of St. Paul, Covent Garden.

A. D. 1649, a pendulum clock was constructed by Vincenzio Galileo (the younger Galileo).

A. D. 1650, Huyghens constructed clocks on this principle: — He first explained the nature, properties, and application of the pendulum, and made it perfect, except the compensation added by Graham, about 1700.

Anchor pallets were introduced by Clement, in 1680, who also devised the mode of suspending the pendulum from a stud, by means of a piece of watch-spring. The mechanism of repetition by means of pulling a string was invented by Barlow, 1676. The endless cord, to continue the clock in regular motion, during the time of winding up, was invented by Huyghens, 1660. This was otherwise effected by Harrison, 1735, by means of his anxiliary spring and additional ratchet. See GOING-WHEEL. Huyghens was also the contriver of the present dial-work for changing the hour into sixty minutes which divide the circumference of the dial, traversed by an additional hand in the center of the clock-face.

Clocks were applied to purposes of astronomy as early as 1484. Gemma Trosius, in 1530, suggested their use at sea for acertaining the longitude. In 1741, the English government offered a reward of £20,000 for a correct mode of determining longitude at sea. This was won by Harrison, in 1762, who invented and introduced the compensating pendulum balance, made of two metals. See BALANCE; CHRONOMETER.

The balance-spring, which confers upon the balance the isochronal qualities of the pendulum, was invented by Hooke, who applied it in a straight form. Huyghens changed it to a helix.

Graham invented the dead-beat escapement in 1700. See ESCAPEMENT.

The spring as a motor for time-pieces was invented by the Germans, and was rendered necessary to confer portability upon the invention. It was first placed on the arbor of the great wheel and a supplementary spring opposed the former during the first part of its unwinding. This was intended to counteract the inequality. The fusee was afterwards introduced. A watch with a fusee, made in 1525, by Lech, of Prague, was in London a few years back.

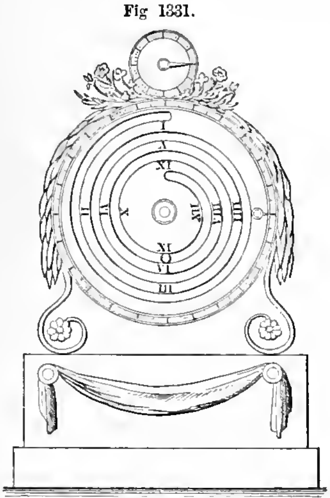
Musical or chiming clocks were invented in Germany. Burney notices them as early as 1580.

In 1544, the corporation of master clock-makers of Paris obtained a statute from Francis I., forbidding non-admitted persons to make *clocks, watches*, or *alarums*, large or small.

Benjamin Franklin's clock is noted as being the simplest on record. It shows the hours, minutes, and seconds, and yet contains but three wheels and two pinions in the whole movement. The lowest wheel has 160 teeth, and makes one revolution in four hours. It carries the hand on its axle, which points out both the hour and the minute. It turns a pinion of ten leaves, on the same axis with which is a wheel of 120 teeth that gives motion to a pinion of eight leaves. The second-hand is attached to the axis of this latter pinion, as also the swing-wheel, which carries thirty teeth, that gives motion to the pallets of an anchor-escapement, and to its pendulum, that vibrates seconds.

The dial of this clock has an external circle having 240 divisions in four successive notations of sixty each. This circle shows the minutes; within it the hours are arranged in a volute of three revolutions along four radii which form right angles with each other. By this arrangement, while the point of the hand shows the minute, the side shows the hour, or, more strictly speaking, that the hour is one of three at four hours' distance apart. It is supposed that there will be no mistake as to the reading, to the extent of four hours' difference. A small circle above the great one is divided into sixty parts for seconds.

Fig 1331.



Franklin's Clock

The clock is wound up by a line going over a pulley and ratchet on the axis of the great wheel.

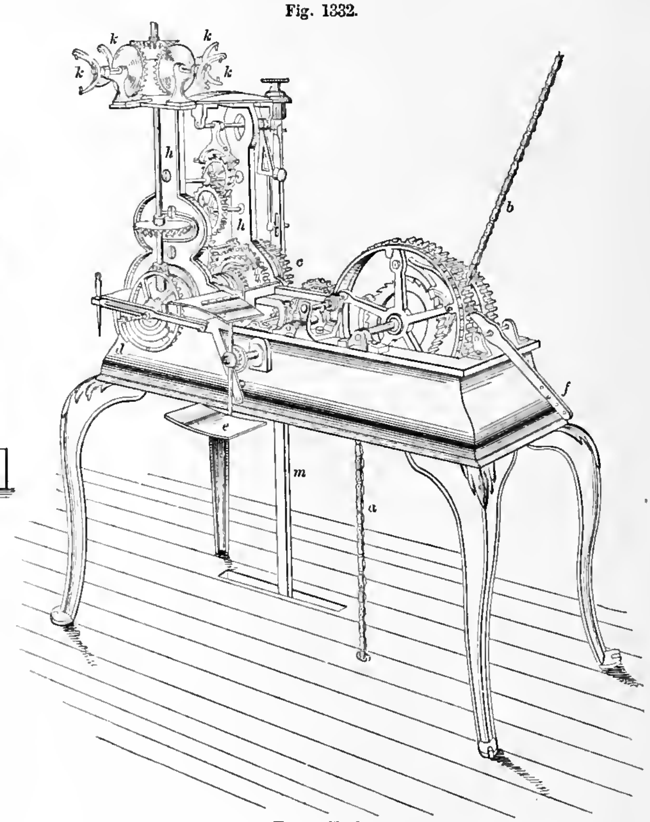
To remedy the imperfection in this clock, of the uncertainty of which hour of three it denotes, the spiral coil containing the hours has been changed to a groove of like form carrying a ball which constantly seeks the lowest position, and thus indicates the hour by proximity to the figures on the spiral.

Rev. John Wesley in his journal gives the following account of a talking clock: —

"On Monday, April 27, 1762, being at Lurgan, in Ireland, I embraced the opportunity which I had desired, of talking to Mr. Miller, the contriver of that statue which was in Lurgan when I was there before. It was the figure of an old man standing in a case, with a curtain drawn before him, over against a clock, which stood on the opposite side of the room. Every time the clock struck he opened the door with one hand, drew back the curtain with the other, turned his head as if looking round on the company, and then said, with a clear, loud, articulate voice, past one, or two, or three, and so on. But so many came to see this (the like of which all allowed was not to be seen in Europe), that Mr. Miller was in danger of being ruined, not having time to attend to his own business. So as none offered to purchase it or reward him for his pains, he took the whole machine to pieces."

Church clocks, or, as they are termed in the trade, *tower* clocks, are very diverse in their appearance from any hall or mantel clock. The clock in the illustration is supported by four legs upon the floor of the elevated apartment in the clock-tower, and is driven by two weights. *a* is the chain by which the *going* weight is suspended; the chain *b* of the striking weight passes upward, over a pulley, and is thence suspended. Each chain, of course, keeps up a constant strain upon its own train, the *going* train

Fig. 1332.



Tower Clock.

affording through the escapement the urging pressure upon the pendulum-rod *m*, which keeps its motion even, and neutralizes exactly its tendency to beat gradually in a smaller and smaller arc, and eventually run down. The *striking* train keeps that portion of the machinery in constant readiness to respond whenever it is released by the recurrence of the completed hour. *c* is the *hour-wheel* and *d* the *snail*, the latter determining the number of blows, while the *fly e* regulates the rate of the striking, that is, the interval between the blows; *f* is the *striking-lever*.

The going train is principally between the standards *h h*, between which is seen the anchor of the escapement. The gimbals *k k k k* connect to as many rods, which drive the *motion-work* behind the dials, situated in the four faces of the tower respectively.

The clock of Beauvais, France, is composed of fourteen different movements consisting of 90,000 pieces, weighing over 35,000 pounds, and costing £5,600. The body of the clock is 36 feet high, and 16 feet in breadth by nearly 9 in depth. The main dial — there are fifty in all — is the largest work in enamel in existence, and cost $650. Two hands of steel covered by platinum move over this dial through twenty-four divisions; it is pierced, as are all the others, and shows the pendulum, weighing nearly one cwt., which renews its impulse from a steel ball weighing a gramme, or about one thirty-second of an ounce. This movement impels the fourteen others, and is wound up weekly, being driven by weights in the usual way. The other dials are calendars of the days of the week and of the month, the month, year, zodiacal signs, eclipses, phases of the moon, etc. This clock shows seconds of time, and indicates events occurring not oftener than once in 100 years; for instance, it must be remembered that three centuries out of four the last year leaps its bissextile. In these years the clock has to leap from February 29, and goes from the 28th to the 1st of March. Here is a movement occurring only in 400 years.

A Strasbourger, jealous for the honor of his town-clock, seeks to outrank these Beauvais claims, and says: —

"Our cathedral clock shows all these indications and some besides. It contains an ecclesiastical computator with all its indications; the golden number, the epacts, dominical letter, solar cycle, etc.; a perpetual calendar with the movable feasts, a planetarium on the Copernican system, showing all the mean equinoctial revolutions of every planet visible to the naked eye; a celestial sphere showing the precession of the equinoxes, the solar and lunar questions for the reduction of the mean motion of the sun and moon to true time and place. The Beauvais clock makes a change in every fourth century; but ask an astronomer what is meant by the precession of the equinoxes. He will tell you it is a movement in the stars describing a complete revolution round the earth in the space of about 25,000 to 26,000 years. In the Strasbourg clock is a sphere following exactly this motion, and whose rotation is of that kind as to insure one revolution in 25,920 years. The thing can be measured and indicated; it is unnecessary to await its accomplishment."

The wooden-clock manufacture was commenced in Waterbury, Connecticut, by James Harrison, in 1790, on whose books the first is charged January 1, 1791, at £3 12s. 8d. In East Windsor the brass-clock manufacture was carried on by Daniel Burnap. In 1793, Eli Terry, who had been instructed in the business by Burnap, made brass and wooden clocks, with long pendulums; price for a wooden clock and case, from $18 to $48, the higher priced ones having a brass dial and dial for seconds, and the moon's age, and a more costly case. Brass clocks with a case cost from $38 to $60.

Terry used a hand-engine for cutting the teeth of the wheels and pinions, and a foot-lathe for the turned work. In November, 1797, he patented an improvement in clocks, watches, and time-pieces, covering a new construction of an equation clock, showing the difference between apparent and mean time. In 1802, in which year Willard of Boston took a patent for his time-pieces, Terry began the business on a larger scale by water power. In 1814 he introduced a new era in the business by commencing on the Naugatuck River the manufacture of the shelf or mantel clock, which he patented in 1816. The cheapness of these created a wide demand. Several improvements made by him in the mechanism, and the later progress in machinery generally, have increased the annual production in that State to hundreds of thousands, and given to every household a clock, equal to the old ones, at a cost of $2 and upward. His descendants have been engaged in the business to the present time, and his pupil, Chauncey Jerome, since 1821.

The Assembly of Connecticut, in October, 1783, awarded a patent for fourteen years to Benjamin Hanks, of Litchfield, for a self-winding clock. It was to wind itself by the help of the air, and to keep more regular time than other machines. The principle was made use of in New York and elsewhere.

Several ingenious applications of natural pulsations have been made to effect the same purpose: Washburn's Thermal-motor, for instance, in which the expansion and contraction of bars of metal is made by differential levers and ratchets to wind the spring.

Clocks with hands and dials having a common center are arranged to show the time at places having different longitudes. A number of concentric circles are marked upon the dial of a watch, each of which is marked with the name of a place. The several hands correspond to the number of circles, and are constructed of different lengths. The hands move upon a common center, but are capable of an adjustment, so that the distances between each of them may be made to correspond to the difference in time of the places marked on their respective circles.

An *astronomical* clock is one which has a compensating pendulum and otherwise of marked quality, used in determining time in observations.

A *chiming* clock is one in which the hours or fractions are marked by a carillon.

An *electric* clock is one whose movements are regulated by electro-magnetic devices.

A *regulator*, or watch-maker's clock of superior quality for regulating time-pieces.

A *sidereal* clock, one regulated to sidereal time, not mean time.

Clock-a-larm'. A device in a clock, which is capable of such arrangement that when a certain hour is reached a repetitive alarm shall be struck upon a bell.

An alarm arrangement was attached to the water-clock constructed in France, in the last century. The clock consists of a cylinder divided into several small cells and suspended by a thread fixed to its axis, in a frame on which the hour distances, formed by trial, are marked out. As the water flows from one cell to another, it changes very slowly the center of gravity of the cylinder, and puts it in motion. The alarm "consists of a bell and small wheels, like those of a clock that strikes the hours, screwed to the top of the frame in which the cylinder is suspended. The axis of the cylinder, at the hour when one is desirous of being wakened, pushes down a small crank, which, by letting fall a weight, puts the alarm in motion. A dial-plate with a handle is also placed within the frame."

Clock-move'ment Ham'mer. The striker of a clock which sounds the hours upon the bell or gong.

Clock-pil'lar. One of the posts which connect, and at the same time hold at the prescribed distance apart, the plates of a clock movement.

Clock-spring. A coiled steel spring in the going-barrel or the striking-barrel of a clock which impels the train or strikes the hours, as the case may be. The steel ribbon from which the springs are made is about 3 inches wide, and is split by circular shears into widths $1\frac{1}{2}$ inches to $\frac{3}{16}$ of an inch, for the different powers required. Pieces of the same breadth are riveted together at the ends to make them continuous, are coiled on a reel, from which they pass to be hardened, tempered, polished, and colored. The heating is done by passing the steel ribbon through a red-hot iron tube 6 feet long, 6 inches wide, and 2 inches deep, which is laid lengthways of a furnace of suitable length, so that, while the ribbon is heated by the red-hot tube, it will not come in contact with the fuel. As the ribbon emerges from the hot tube, it passes into a bath of oil in a tank six feet long and kept cool by a water-jacket through which a stream constantly passes. It then passes through a bath of molten lead, which gives it the necessary temper; then between iron rollers, which are the medium of determining the rate of motion of the ribbon through the heating-tube, the hardening-bath, and the tempering-bath. The rate of progression is about 1,000 feet per day, and of narrower ribbons several may be passed at a time. From the rolls the ribbons are again wound over reels and taken to be polished and colored. The ribbon is then passed over and under leather-covered wooden rollers revolving in boxes of emery, by which both surfaces of the steel are polished; at the same time two vulcanite wheels smooth and round the edges. It is then passed through a bath of molten lead, which gives it its color; after cooling it is cut into lengths, the ends softened, the hooks and eyes put on, and the springs coiled up and packed for sale.

Clock-watch. A watch adapted to strike the hours and quarters similarly to a clock, as distinguished from a *repeater*, which strikes the time only when urged to do so,— by pushing in the stem, for instance.

Clock-work Lamp. Carcel's clock-work lamp pumps up oil from the reservoir in the foot of the lamp and overflows back again from the burner to the reservoir, the flow being in excess of the consumption so as to prevent the heating of the metallic portions around the wick. The clock-work is run by a spring or a descending weight, according to circumstances of size, position, purpose, or requirements of portability. In lighthouses, the excessive supply inducing overflow is a necessary feature, to secure uniform supply, and the arrangement differs from the domestic form of lamp.

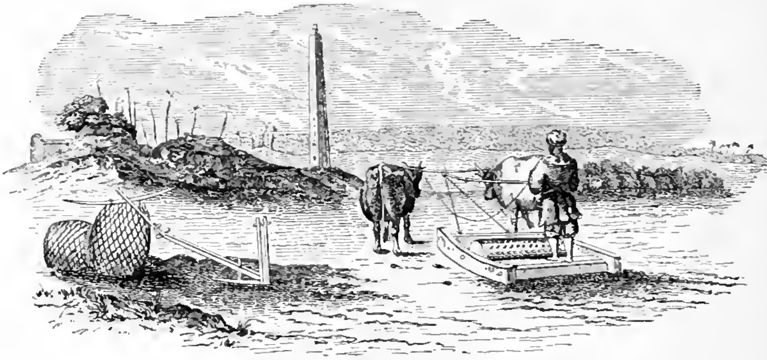
De Kerevenan's clock-work lamp has a fan driven by clock-work in the stem or foot, furnishing a blast of air on each side of a flat wick to urge the flame and perfect the combustion of the carbon of the oil. This may be or has been applied to Argand lamps.

Clock-work has been applied to lamps and to gas-burners to light them at a specific prearranged time, the device being on the principle of the alarm clock and operating upon a lever or trigger to light a match, close an electric circuit, or by other means.

Clod-crush'er. The modern Egyptians use a machine called *khonfud, hedgehog,* to break the clods, after the land has been plowed. It consists of a cylinder, studded with projecting iron pins. The land shown in the cut is in the vicinity of the ancient Heliopolis, and within sight of the minarets of Cairo.

One form of clod-crusher consists of a series of cast-metal rings, or roller-parts, placed loosely upon

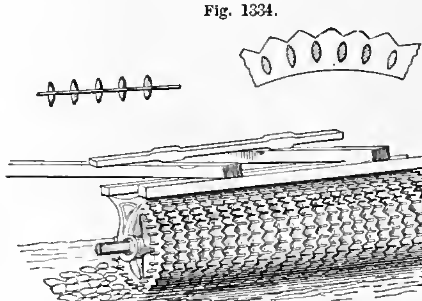
Fig 1333.



Egyptian Clod-Crusher (from Wilkinson).

a round axle, and revolving thereon independently of each other, so as to produce a self-cleaning action, and enable the machine to be readily turned round about. The surfaces of the roller-parts are pointed with serrated edges and a series of inner teeth, projecting sideways, fixed at a particular angle to the center of the roller-axle, so as to act most effectually in penetrating clods perpendicularly, and in consolidating the young plants in the soil. The roller is removed from place to place on two traveling

Fig. 1334.



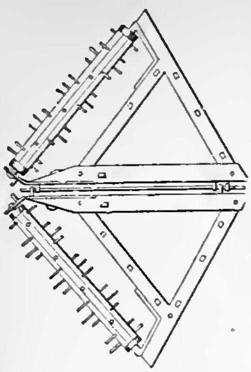
Crosskill's Clod-Crusher.

wheels of larger diameter, which lift the roller-parts clear off the ground. When the roller has arrived in the field where it is intended to be used, the wheels are removed.

Another form of clod-crusher has spiked rollers attached in the rear of a harrow.

Clog. A protection for the foot worn over the shoe. The sole is elastic, being made of leather or else having a hinge in the shank. A toe-cap, heel-piece, and instep-strap hold it on the foot. Beneath the sole-piece are an extra sole and heel-tap, made of wood.

Fig. 1335.

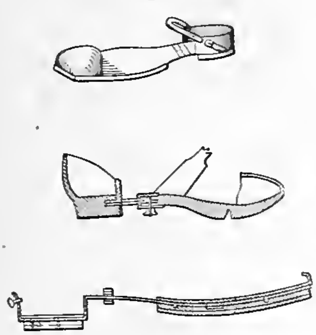


Clod-Crusher.

It is yet much used in Europe, but goloshes or india-rubber overshoes have to a considerable extent superseded the clog.

The clog is an ancient form of foot-wear, and consisted of a leathern upper and wooden sole; the upper was nailed to the edge of the sole; the latter was sometimes an inch thick, and often hooped with sheet-iron. They were worn by the Greeks and Romans, and are still common in Italy, Spain, and Portugal. They are known as *sabots* in France; *galochas, tamancos,* and *zuccos* in other parts of the Continent of Europe.

Fig. 1336.



Clog.

The Sabotiers, an order of friars which originated in the fourteenth century, vowed to "be shod with wooden shoes," probably as an improvement on the barefooted Carmelites. They were formerly worn by kings, came to be regarded by the populace of England as representing Popery and slavery, and formed the burden of popular outcry, aiding in the expulsion of James II. from the country. The cry of the mob, "No slavery, no wooden shoes," made Walpole's life uneasy.

Clois'ter. (*Architecture.*) A covered ambulatory.

Close-butt. (*Shipbuilding.*) A fayed or rabbeted joint where the parts are so closely fitted or driven as to dispense with calking.

Clos'er. (*Masonry.*) *a.* The last stone or brick in a horizontal course closing the gap.

b. A brickbat inserted in course when the gap will not admit a whole brick.

A *king closer* is a bat, three quarters the size of a brick. A *queen closer* is a quarter-brick.

Close-stool. A commode or box with tightly fitting lid to contain a chamber-vessel. A *chamber-stool.*

Close-wall. (*Building.*) An enclosing wall.

Clos'ing-ham'mer. A hammer used by boiler-makers and iron ship-builders for closing the seams of iron plates. See RIVETING-TOOLS.

Cloth. (*Fabric.*) A woven fabric of cotton, linen, or wool. Silk perhaps hardly comes within the category. See FABRIC for list of woven goods.

Woolen cloth, after weaving, is subjected to the following processes: —

Braying or *scouring:* that is, washing in troughs with heavy mallets, water and detergents being used to remove the oil and all acquired filth.

Burling: picking off the knots made by the weaver.

Milling or *fulling:* to felt the fibers of the cloth closer together, increasing the compactness of the fabric and the finish of the face. See FULLING-MILL.

Dressing: this is done by teasels, whose hooked ends bring the loose fibers to the surface to form a nap. See TEASELING; DRESSING.

Shearing: the filaments drawn out by the teasels are shorn or singed to a length. See CLOTH-SHEARING MACHINE.

Pressing: the cloth is arranged in regular folds and subjected to hydrostatic pressure. A polished pressing-board is placed between each fold. See CLOTH-PRESS.

Some of the later processes of the cloth-manufacture are varied or combined.

Hot-pressing, boiling, steaming, are each of them means for giving a fine finish by the application of heat.

Picking is a process of removing blemishes by tweezers, or coloring faulty spots by a hair-pencil and dye.

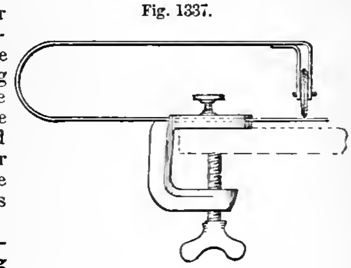
Fine-drawing is closing minute holes or faults in the fabric, by inserting sound yarns by means of a needle.

Marking consists in working-in with white or yellow silk a word or mark indicating the quality of the piece.

Baling and *packing* conclude the series of processes.

Cloth-creas'er. A device which may be clamped to the table or the sewing-machine, the crease being made by the adjustable bevel-edged wheel under which the fabric is drawn.

Fig. 1337.



Cloth-Creaser.

Cloth-cut'ting Ma-chine'. A machine for cutting cloth into strips, or into shapes for making into garments.

Among the various forms and modes may be cited: —

Knives corresponding in shape to the various parts of a garment are mounted upon a reciprocating platen, and descend upon the material piled in thicknesses upon the bed beneath. Envelope blanks are cut out of the sheet in this manner.

A guillotine knife, straight or curved, and descending vertically.

A knife or saw reciprocating vertically in a constant path like a scroll saw, while the pile of cloth below is moved beneath so that the saw or knife follows a line marked upon the upper layer of cloth. The knife is reciprocated like the needle of a sewing-machine, and a presser foot holds the material. It has also an intermittent feed.

A band-saw acting in the same manner.

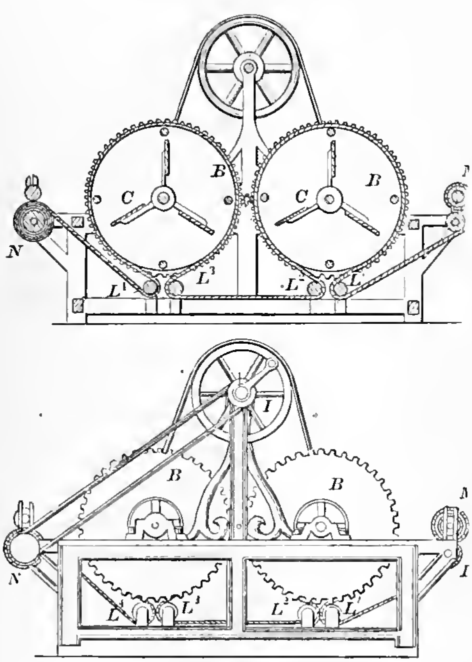
A rotary cutter mounted on a vertical spindle which allows the edge of the knife to be presented in any direction.

A mandrel with rotary cutters to cut cloth into strips for carpet or for other purposes.

Cloth-dress'ing Ma-chine'. A machine in which the nap of woolen cloth is raised by teasels. See TEASELING-MACHINE. Also known as a *gigging-machine*.

Cloth-dry'ing Ma-chine'. A machine with heated rollers over which cloth is passed to drive off the moisture acquired in dyeing, washing, etc. In the example, *M* is the feed-roll from which the cloth unwinds; it thence passes over the cylinder *B B*, against whose surface it is tightly drawn by

Fig. 1338.



Cloth-Dryer.

the guide-rollers L^1 L^2 L^3 L^4, while the fans *C* drive a current of air through the meshes of the wire-gauze cylinders and the cloth. *N* is the take-up roller on which the cloth rewinds.

A steam cloth-dryer shown at the Paris Exposition had an annular steam-chamber constructed of two concentric cylinders, which formed a closed cavity, and constituted the circumference of a wheel more than 12 feet in diameter. Around the circumference of this wheel, which turned slowly upon a horizontal axis, the cloth was carried, being kept in position by means of two endless chains having tenter-hooks attached. The cloth passed round nearly the entire circumference, being carried off on the same side at which it was introduced; the velocity of motion at the circumference was about six inches per second.

The construction permits the steam-chamber to be made very secure against accident, and yet to present an exterior of quite thin metal, facilitating greatly the transmission of heat. The necessary strength is obtained by means of numerous interior stays connecting the two cylindrical surfaces. The steam is admitted through the axis.

Cloth Em-boss'ing. This is performed in a rolling-press, the engraved cylinders of which act upon the fabric (or paper), which is passed continuously between them; or one or more of the cylinders may be printing-cylinders having the usual color-vats and doctors.

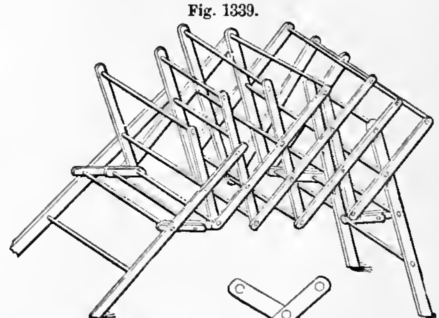
Clothes-brush. A brush usually having good black Russian bristles, adapted for brushing cloth.

Clothes-dry'er. A frame on which clothes are suspended to dry. Among the multitude of forms may be mentioned the post with extensible bars and parallel cords, Fig. 1339; this may be dismounted and collapsed like an umbrella. The toggle-jointed frame, with cross-rounds like a ladder, and folding up on the lazy-tongs principle. Others are clothes-horses, consisting of frames with cross-bars, and shutting together like book-covers. Another form has radial bars like spokes, or a slatted frame hinged like a trap door, etc., etc.

The centrifugal machine is used to remove all the moisture that can be got rid of by mechanical means.

Clothes-horse. A form of clothes-dryer which stands on legs and has cross-bars on which clothes

Fig. 1339.



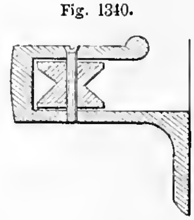
Clothes-Horse.

may be suspended to dry. The figure shows numerous rounds on a frame collapsable on the lazy-tongs principle.

Clothes-line. A cord or wire for suspension between posts or other supports. It is preferably of white cord, and wound on a reel in the intervals of non-use. If left exposed tinned iron wire is good.

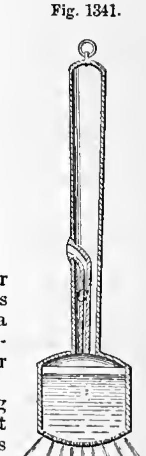
Clothes-line Hook. A hold-fast or bracket, with a spool on which the line runs and is stretched.

Fig. 1340.



Clothes-Line Hook.

Fig. 1341.



Clothes-Sprinkler.

Clothes-line Reel. A cylinder or axle, on which a clothes-line is wound and usually journaled in a protected bracket or under a pent-roof secured against a building or tree.

Clothes-pin. A little spring nippers which pinches a garment against the line from which it is suspended to dry. It may be a split pin; a pair of hinged fingers with a spring enclosed; a bent wire having a bight which yields and clasps, etc.

Clothes-pins are turned and slotted in machines specially constructed therefor.

Clothes-press. 1. A receptacle for clothes. A closet.

2. A press in which clothes are flattened and creased; crape shawis, for instance. See CLOTH-PRESS.

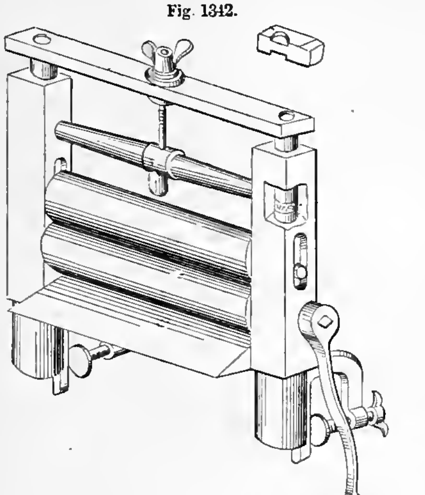
Clothes-sprink'ler. A receptacle for water, with perforations through which a fine shower of water is thrown upon clothes in damping them previous to ironing.

Clothes-stick. A rod by which clothes are turned, loosened, or lifted, while in the wash-boiler.

Clothes-tongs. A grasping-tool for removing hot clothes from a boiler, in washing or dyeing.

Clothes-wring'er. A frame having a pair of elastic rolls, through which clothes are passed to squeeze out the water. The improvement concerns

Fig. 1342.



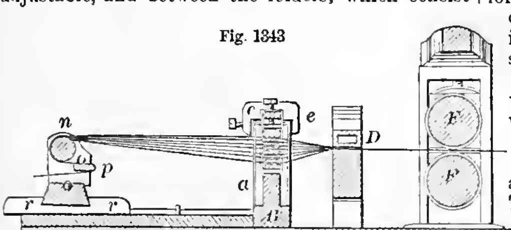
Clothes-Wringer.

springs for pressure, modes of gearing, material of rollers and modes of securing them to their shafts, modes of securing the wringer to the side of the tub. See WRINGER.

Cloth-fin'ish-ing Ma-chine'. One for *teaseling* and *shearing;* raising the nap, and bringing it to an even length. See TEASELING; SHEARING; NAPPING.

Cloth-fold'ing Ma-chine'. One in which wide goods are folded lengthwise, ironed and pressed ready for baling. In the example the cloth is passed over the bulging, spreading roller *n*, which is adjustable, and between the folders, which consist

Fig. 1343



Cloth-Folding Machine.

of a plate bent into a sinuous form like a flattened **S**. From the folders the cloth passes beneath the inclined steam-heated ironer *D*, and from that to the rollers *F F*, by which it is drawn forward.

Cloth'ing 1. (*Steam.*) An outside covering of felt, or other non-conducting material, on the outside of a boiler or steam-chamber to prevent radiation of heat. *Cleading; lagging.*

2. (*Carding-machine.*) Bands of leather studded with teeth of wire which engage the fiber. See CARDING-MACHINE.

The following names of parts of clothing are used in a mechanical sense: —

Band.	Hoop.
Belt.	Jacket.
Bonnet.	Lining.
Boot.	Pocket.
Breeching.	Seam.
Button.	Shoe.
Cap.	Skirt.
Collar.	Sleeve.
Cuff.	Sole.
Hat.	Yoke.
Hood.	

3. (*Menage.*) Full horse-clothing consists of the quarter-sheet, breast-piece, hunting-piece, pad-cloth, hood, body-roller, and knee-caps.

Cloth-meas'ur-ing Ma-chine'. A machine by which fabrics made in great lengths are measured off in pieces of convenient length for sale, and hence known as piece-goods.

Cloth-pa'per. Heavy paper used between folds of cloth, in the finishing-press.

Cloth-plate. That plate in a sewing-machine on which the work rests, through which the needle passes, and beneath which is the looper, or the lower spool or shuttle, as the case may be.

Cloth-press. A hydrostatic press in which woolen cloths are subjected to pressure.

The cloth is arranged in regular folds, a polished pressing-board being arranged between each fold to prevent contact of the cloth surfaces with each other. Between each two pieces of cloth is an iron plate.

For *hot-pressing*, three hot iron plates are inserted between the folds at intervals of about twenty yards. Cold iron plates next to the hot ones moderate the heat. Pressure is then applied, and the pile allowed to stand till cold. The cloth is then taken and re-piled, so that the creases of the former piling come in the middle of the pressing-boards at the second pressure. Hot pressing gives a lustrous appearance, but is apt to spot with rain.

Boiling and *steaming* have been substituted for hot-pressing, or used in connection therewith.

In the former the cloth is wound tightly upon a wooden or iron roller, immersed in water heated to 180° F., steeped for five hours, taken out and cooled for twenty-four hours. It is treated in this way four or five times; is washed with fuller's earth. It is then stretched on a tenter-frame and dried in a steam-heated room.

In *steaming*, after the cloth is *hot pressed*, it is wound around a perforated copper roller, into which steam is then admitted. If at high pressure, it will pass through all the folds in a few minutes; if at low pressure, it will require one and a half hours. After this it is boiled twice. This steaming saves the time of three boilings.

Cloth-prov'er. A magnifying-glass employed in numbering the threads in a given space of cloth.

Cloth-shear'ing Ma-chine'. A machine for cutting to an even length the filaments of wool drawn out in the process of *teaseling.* It was formerly done by hand.

One cloth-shearing machine consists of a fixed semicircular rack concentric with a cutting-edge called a *ledger-blade*, and a large revolving wheel containing eight small cutting-disks, whose shafts have pinions which engage with the teeth of the semicircular rack, so as to give the cutting-disks a rotary motion on their axes, in addition to their revolving motion with the large wheel. The machine travels over the cloth, or the cloth under the machine, as may be arranged.

Revolving shears are used for shearing off the loose fibers from the face of woolen cloths. For narrow cloths the cylinders are 30 inches long and 2 in diameter; 8 thin knives are twisted around the cylinder, making 2½ turns in the length, and are secured by screws and nuts which pass through flanges at the end of the axis. Formerly the cylinders were grooved and fitted with thin, narrow plates of steel 6 or 8 inches long. The edges of the 8 blades are ground, so as to cons'itute parts of a cylinder, by a grinder or strickle fed with emery, passed to and fro on a slide parallel with the axis of the cylinder, which is driven at about 1,200 turns in the minute.

In use, the cylinder revolves at about the same rate, and in contact with the edge of a long, thin plate of steel, called the ledger-blade, which has a very keen rectilinear edge, whetted to an angle of about 45°; the blade is fixed as a tangent to the cylinder, and the two are mounted on a swing-carriage with two handles, so as to be brought down by the hands to a fixed stop. The edge of the ledger-blade is sharpened by grinding it against the cylinder itself, with flour, emery, and oil, by which the two are sure to agree throughout their whole length.

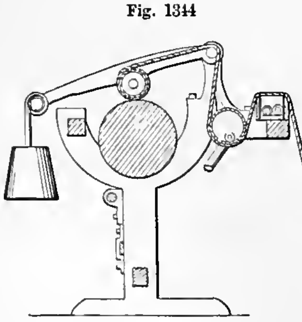
The cloth, before it goes through the process of cutting, is brushed, so as to raise the fibers; it then passes from a roller over a round bar, and comes in contact with the spring-bed, which is a long elastic plate of steel, fixed to the framing of the machine, and nearly as a tangent to the cylinder; this brings the fibers of cloth within the range of the cutting-edges, which reduce them very exactly to one level.

This machine has several adjustments for determining with great nicety the relative position of the ledger-blade, cylinder, and spring-bed.

Formerly the cloth was passed over a fixed bed having a moderately sharp, angular ridge; but this was found to cause holes in the cloth.

Broadcloths require cylinders sixty-five inches long, and machinery of proportionately greater strength. In Lewis's patent cloth-cutting machine (English) the cloth is cut from *list* to *list*, or transversely, in which case the cloth is stretched by hooks at the two edges, and there are two spring-beds; the cylinder in this machine is forty inches long, and the cloth is shifted that distance between each trip, until the whole piece is sheared.

Fig. 1344



Cloth-Smoothing Machine.

Other fabrics, such as carpets, are sheared by the same description of machine.

The lawn-mower operates on the same principle.

Cloth-smooth'ing Ma-chine'. A smoothing and ironing device for cloth in the piece. The cloth is damped and heated by passage over a trough inclosing a perforated steam-pipe, and then beneath a hollow heated cylinder. The winding roller is journaled in a weighted frame, and the cloth is wound while under pressure between the said roller and the main cylinder.

Cloth-spong'er. A device for damping cloth previous to ironing. In machines for this purpose the cloth is sponged by steam applied through a perforated adjustable horizontal cylinder around which it is rolled.

Cloth-stretch'er. A machine in which cloth is drawn through a series of frictional stretching-bars and passed over spreading rollers so as to equalize the inequalities on its surface and enable it to be firmly and smoothly wound on the winding-roll.

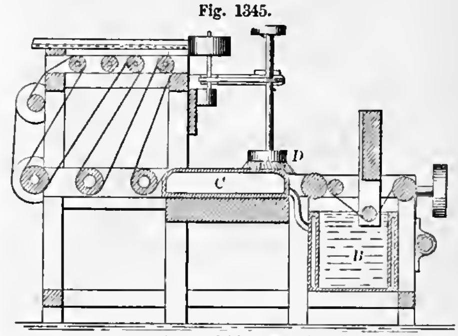
Cloth-tear'ing Ma-chine'. A machine having a fluted roller and knife-edges. The latter push the cloth into the flutes and tear it into strips as it passes through the machine.

Cloth-teaz'ler. A machine for raising the nap of cloth. See TEASELING-MACHINE.

Cloth-var'nish-ing Ma-chine'. For making the enameled or varnished fabric.

The cloth is passed from the let-off roller beneath a roller in the steam-heated size-vat *B*; thence to a steam-heated table *C*, where the varnish is spread

Fig. 1345.



Cloth-Varnishing Machine.

by a revolving brush *D*, and thence over the rollers of the drying-frame, where it is exposed to jets of air from a perforated pipe, and from which it is wound on a take-up roller.

Cloth-wheel. 1. A grinding or polishing wheel, covered with cloth charged with an abrading or polishing material; as, *pumice-stone, chalk, rotten-stone, crocus, putty-powder, rouge*, etc.

The cloth used is heavy, similar to that used for the blankets of printing-presses. Felted cloths are sometimes used.

The cloth-wheel is used by opticians, lapidaries, and ivory-workers.

2. A form of feed-movement in sewing-machines. A serrated-faced wheel protrudes upwardly through the cloth-plate, and has an intermittent motion.

Cloud'ing. 1. An appearance given to silks and ribbons in the process of dyeing.

2. A diversity of colors in a yarn recurring at regular intervals.

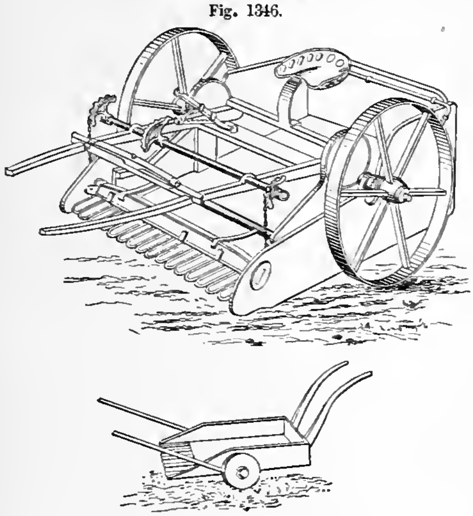
Clough A sluice used in returning water to a channel after depositing its sediment on the flooded land.

A *floating clough* is used for scouring out some of the channels of the Humber. It consists of a frame covered with plank, and having a central culvert and sluice. In front are timbers shod with iron in serrated form, which can be raised or lowered at pleasure. Side wings are sloped to accommodate themselves to the inclination of the banks. When the water is at high tide the clough is floated up stream and sunk in the channel by admitting water; and the wings extended by ropes. At full ebb the serrated frames are let down, the machine allowed to yield to the body of water above, which forces it along, the teeth scraping up the mud, and the current carrying it off.

Clout. (*Carriage.*) An iron shield or plate placed on a piece of timber in a carriage — as on an axle-tree — to take the rubbing and keep the wood from being worn.

Clout-nail. *a.* One with a large flat head. Such are used to stud timbers exposed to the action of marine borers; also in fastening leather to wood.

Fig. 1346.



Stockstill and Scarf's Clover-Seed Harvester.

b. A long blunt stub-nail for boot-soles.

c. A flat-headed nail, used for securing *clouts* on axle-trees or elsewhere.

Clove. (*Fr. Clou.*) A long spike-nail.

Clove-hitch. (*Nautical.*) Two half-hitches. A half-hitch is to give the rope a turn around the object, pass the end of the rope round its standing-part, and then through the bight. To make a *clove-hitch*, repeat the motion around the standing part and through the bight, and stop the end to the standing-part. See HITCH.

Clove-hook. (*Nautical.*) An iron two-part hook, the jaws overlapping; used in bending chain sheets to the clews of sails, etc.

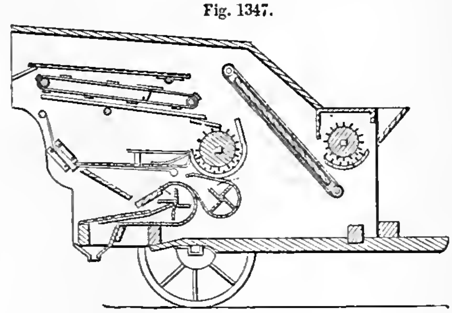
Clo′ver-seed Har′vest-er. Fig. 1346 illustrates one mode of harvesting clover-seed, and resembles the first of which we have any record. A wheat-harvester on this principle was running in Gaul, in the first century of the Christian era, and the machine continued in favor for 300 years, although it does not appear to have been used in Italy. In front of the machine is a row of fingers, between which the stalks of the clover pass, while the heads remaining above are torn off and are scraped into the box of the machine. It is known as a *header*.

In the old machine used 1,800 years ago in Gaul, it was the duty of the attendant to sweep the ears back into the box of the machine, which was driven before the ox that impelled it.

The English clover-harvester of thirty years back, shown in the lower part of same figure, is of the old Gallic pattern, is drawn by one horse, and guided by handles in the rear. The load is scooped out occasionally and deposited in bunches in the field.

Clo′ver-hull′er. Red clover (known in England as "broad clover") came from Flanders to England and from England to the United States. Its adoption was strongly urged by Sir Richard Weston, in 1645, who saw it growing near Antwerp in 1644, and noticed the speed of its growth and how soon it recovered after mowing. In ten years it had spread through the kingdom and made its way to Ireland.

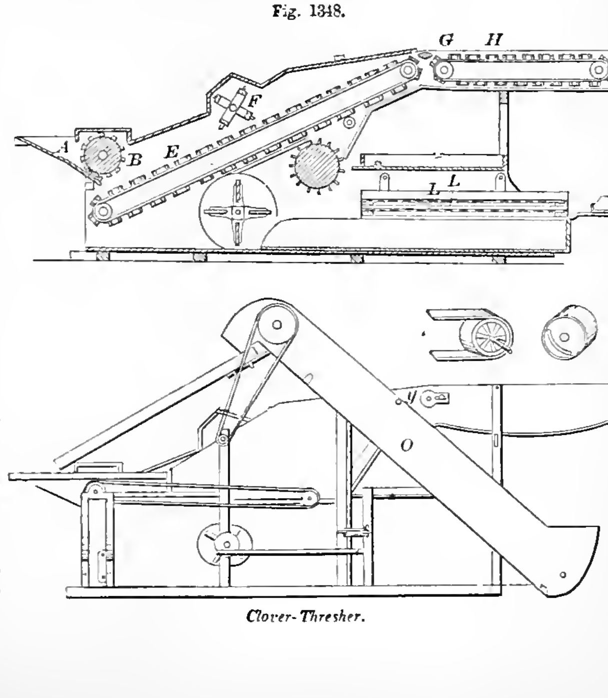
Fig. 1347.



Clover-Huller.

The clover-heads, previously separated from the straw by tramping or thrashing, after passing beneath the thrashing-cylinder, are raised by an endless carrier to a riddle, through which the seed falls upon a carrier which takes it back to the huller, by which

Fig. 1348.



Clover-Thresher.

the seed is liberated from the hulls, to be separated by the fans and riddles.

Clo′ver-thrash′er. A machine in which clover, hay, or the aftermath, which is cut for the seed alone, is thrashed and the seed hulled and cleaned.

The clover is fed in at the throat *A*, thrashed by the cylinder *B*, received on the slatted apron *E*, carried up past the beater *F*, the hay picked off by the picker *G*, and removed by the straw-carrier *H*, while the seed and chaff fall into the shaking-shoe, where the sieves *L*, the vibratory action, and the blast finish the separation and deliver the results separately.

The lower figure shows the outside of the machine, the arrangement of the belting, and the elevator-box *O*, in which the tailings and unhulled heads are carried up to be rethrashed.

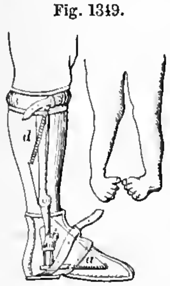
Clow. A sluice with a sliding-gate. See Clough.

Club′bing. (*Nautical.*) Drifting down a current with an anchor out.

Club-com′pass-es. A pair of compasses with a bullet or cone on one leg to set in a hole.

Club-foot, Ap′pa-ra′tus for. Sheldrake's apparatus for club-feet and other deformities (English patent, 1801) proceeds upon the principle of continued, repeated, and varied application of springs to correct the abnormal deflection of the part.

Fig. 1349.



Apparatus for Talipes Varus.

Tiemann's apparatus for *talipes varus* has a strong leather shoe with a metallic sole and a joint near the heel to allow lateral motion. A spiral spring draws the foot outward by a constant, elastic, and easy traction. This pressure is increased or decreased at will, by fastening the spring in a series of sockets.

The single outside upright steel bar with joints at the ankle is fastened round the limb below the knee-joint, and so constructed that the screw at the ankle-joint forces the foot flat upon the floor, which foot in almost all cases is turned under as indicated by the sketch. The spiral spring *d* being attached to a cat-gut cord, passing round a pulley at the center of the bar and fastened near the toes upon the outside of the foot, elevates the toes and stretches the tendo Achillis, at the same time drawing the foot to its natural position.

The apparatus for *talipes valgus* is on the same principle, but with reversed action.

Club-haul. (*Nautical.*) To bring a vessel's head round on the other tack, by letting go the lee anchor, and cutting or slipping the cable, the sails being handled so as to cast the vessel's head in the required direction.

Clump-block. (*Nautical.*) One made thicker and stronger than ordinary blocks.

Clus′tered Arch. (*Architecture.*) Arched ribs of which several spring from one buttress; shown in the Gothic order of architecture.

Clus′tered Col′umn. (*Architecture.*) A pier which consists of several columns or shafts clustered together.

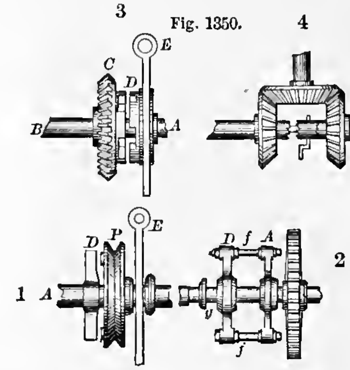
Clutch. 1. (*Machinery.*) A coupling for shafting used in transmitting motion.

The common clutch or gland 1 (Fig. 1350) has a loose band-pulley *P*, which revolves freely upon the shaft *A* except when it is shifted by the lever *E*, so that its projections engage with the gland *D*, which is firmly keyed to the shaft.

The bayonet-clutch 2 has *bayonets f f* attached to a sliding arm *D*, and which slip through holes in the cross-head, which is keyed on its shaft. *D* is secured by a feather on its shaft, and *g* is the seat for the shifting lever.

In 3, the clutch-box *D* is socketed upon the square arbor of the shaft *A*, and may be slipped by the lever *E* either towards or from the counterpart

Fig. 1350.



Clutches.

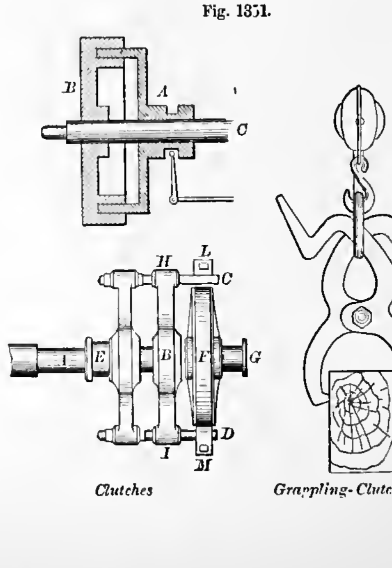
box, which is attached to the constantly revolving cog-wheel *C* and shaft *B*. The faces of the coupling-members have coacting projections and interdental spaces.

4 shows a double-clutch by which the vertical shaft is made to drive the lower one in either direction. The lower shifting-piece is secured by a feather upon the shaft, and may be coupled with either of the bevel-wheels, which otherwise run loosely upon the shaft.

The *cone*-clutch consists of a tapered cylindrical plug sliding on a fast feather in one shaft, and admitting of being forced by a suitable arrangement of levers into the interior of a somewhat similar cylinder fixed on the shaft to be driven.

The *disk*-clutch is another form of friction-clutch, one disk *A* being slipped upon a spline on the shaft *C* so as to impinge upon a rotating disk *B*, and partake of its motion or impart motion thereto by frictional adherence. Friction-clutches are used in heavy machinery so as to start the machines without a sudden jar.

Fig. 1351.



Clutches *Grappling-Clutch*

The lower illustration shows another form of friction-clutch in which a hoop F on the shaft G is set in motion by the bayonet $C\ D\ E$, which is slipped upon the shaft A, the rods $C\ D$ sliding in holes in the cross-head $H\ B\ I$, which is keyed fast to shaft A. When the bayonets project, as in the illustration, they come in contact with the studs $L\ M$ on the hoop, and impart motion thereto. The hoop may be tightened on the wheel, which it incloses to just such an extent as will cause it to impart motion thereto, when revolved, without giving too sudden a jerk in starting.

2. *a.* A gripper in the end of a chain by which it is connected to the object to be moved, as in the foundry-crane, whose clutches take hold of two gudgeons in the cente.s of the ends of the flask, so that a mold can be lifted and turned round in the slings for examination, repair, transposition, or removal.

b. A gripper having teeth which clasp a joist or rafter of a barn to afford a means for suspending tackle for lifting in hay, ice, or what not.

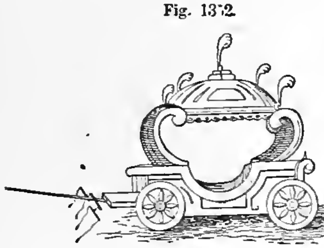
Clys'ter-pipe. The nozzle of an enema syringe.

Clys'ter-syr'inge. A syringe for administering medicines per ano. See ENEMA-SYRINGE.

Coach. 1. (*Vehicle.*) A four-wheeled close carriage with two seats inside, and an outside driver's seat.

The term is found in some form or other in almost all the languages of Europe, and is closely allied to *couch;* reclining in comfort seems to be at the bottom of it. So Mary, Infanta of Spain, wife

Fig. 1352.



Queen Elizabeth's State Coach.

of the Emperor Ferdinand III., thought, as she rode in Carinthia in a close carriage with glass windows. Queen Elizabeth's carriage was rather more solid than graceful.

Hackney-coach; a coach kept for hire.

Stage-coach; one travelling on a regular route, and carrying passengers. The style varies in diferent countries. The stage in England carried six inside and fourteen outside, besides the driver and guard.

Mail-coach; one employed in carrying the mails and passengers. See CARRIAGE; CART; CHARIOT.

2. (*Nautical.*) A cabin on the after-part of the quarter-deck. A round-house.

Coak. 1. (*Carpentry.*) *a.* A projection from the general face of a scarfed timber, of the nature of a tenon, and occupying a recess or mortise in the counterpart face of the other timber. A tabling. The mortise is sometimes known as a *sunk-coak.*

b. A joggle or dowel by which pieces are united to prevent slipping past each other, or to fasten them together. See DOWEL.

2. A square bushing in the sheave of a block, which forms a socket for the pin. See BLOCK.

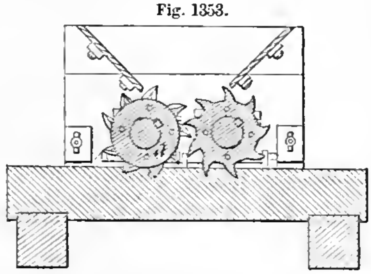
Coal-bor'ing bit. A bit with an entering point and a series of cutting edges of steps of increasing radius.

Coal-break'er. A machine for crushing lump-coal as taken from the mine. Also adapted to cleanse and assort it.

The principle is illustrated in the annexed cut; rollers with spikes.

The new breaker erected near Carbondale by the

Fig. 1353.

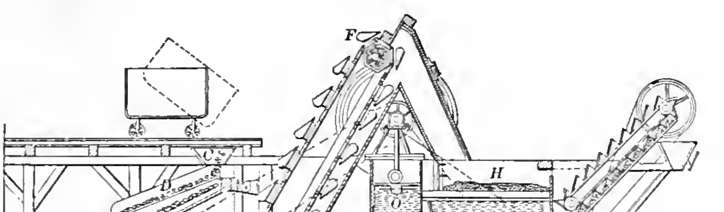


Coal-Breaker.

Erie Railway Company cost $300,000. Some in Schuylkill County have cost over $200,000, and the new breaker of the Delaware, Lackawanna, and Western Railroad Company, near Hyde Park, cost in the neighborhood of $250,000.

In that invented by Berard, shown in Fig. 1354, the coal is carried to a hopper C, whence it falls on to a series of slanting movable gratings or perforated plates D suspended by chains or rods, and operated by a cam motion, by which it is sorted into various sizes. The larger pieces which fall through the first grating fall on the picking-table E, where stones and foreign substances are removed by hand, while the smaller coal passes from the second grat-

Fig 1354.



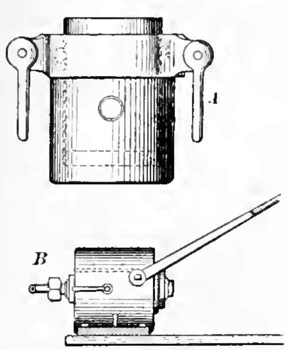
Coal Breaker and Washer.

ing on to the crushing-rollers *F*, and the finest of all, falling on a lower plate, is delivered by the shoot *e* into a pit *c*.

The rollers *F* have longitudinal and transverse grooves, forming projections which break up the thin fragments of slate mixed with the coal, without reducing the latter too much in size. It then falls into the pit *c*, whence the body of coal is elevated by the endless chain of buckets *G F* and carried to the sorter *H*, which separates it according to size for delivery to the boats or cars which are to receive it. The finest portions, which pass through all the gratings of the separator, fall into the tank or bac *K*, through which a current of water is forced by means of a cylinder and piston *O*, raising the broken pieces of slate sufficiently high to be forced through a perforated plate and discharged by the spout *L M*, the flow being regulated by flood-gates, while the coal, in consequence of its greater weight, falls to the bottom of the bac, from which it is removed as often as necessary through a suitable opening.

Coal-break′ing Jack. The jacks *A* are inserted in a small recess made in a seam, and a few feet of flexible tubing taken to an adjacent pump shown at *B*. On working the pump by means of the hand-lever great pressure is obtained, and the coal is brought down in large masses.

Fig. 1355



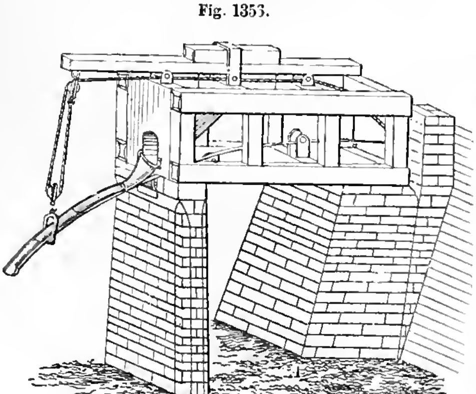
Coal-Breaking Jack.

Coal-bunk′er. (*Nautical.*) The closed room around the boiler and engine-room of a steam vessel for keeping the fuel.

Coal-car. A freight-car designed especially for coal, having facilities for dumping.

Coal-chute. A spout by which coal in bunkers or elevated boxes is loaded into cars or carts. In the illustration it is shown as extensible and vertically adjustable; the former by a rod on rollers, the latter by block and tackle.

Fig. 1356.

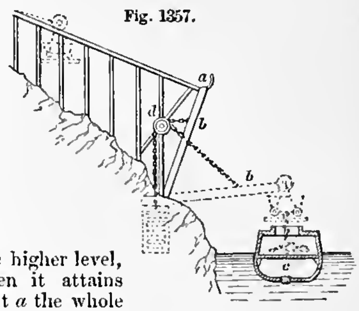


Coal-Chute.

Coal-cut′ting Ma-chine′. A machine for under-cutting coal-seams in the mine or at the bank. See COAL-MINING MACHINE.

Coal-dump′ing Ap′pa-ra′tus. For loading vessels from the car. On top of the rail *a* which forms part of the *staith*, the laden carriage descends from the higher level, and when it attains the point *a* the whole frame *b* with the carriage is lowered down by the chain passing over the pulley at *d*, to the center of the deck of the vessel, and the coals deposited in the hold at *c*.

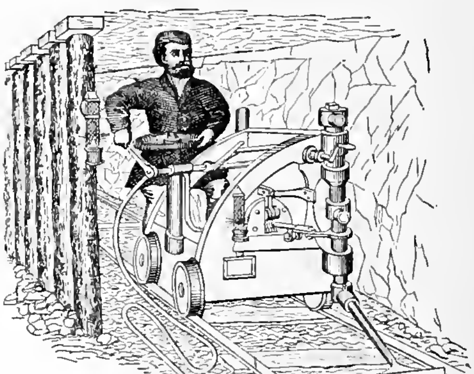
Fig. 1357.



Coal-Dumping.

Coal-min′ing Ma-chine′. One form of the coal-cutting machine has an engine with a reciprocating piston driving a massive steel pick, in any desired direction, and at a very material saving in hewing, or *kirving*. The motive-power of the engine is highly compressed air, condensed by the steam-engine at the mouth of the pit, and this elastic air is conveyed by slender pipes down the shaft and along the mine to the breast where the coal is being worked. The compressed air is pumped by the steam-engine into a receiver at the pit-head during its otherwise idle hours, or by its surplus power when drawing up the coal, or pumping out the water from the mine, and is condensed to a tension of forty or fifty pounds to the square inch. It is conducted in metallic pipes, 4½ inches in diameter,

Fig. 1358.



Coal-Cutting Machine.

down to the bottom of the shaft, and thence in pipes of a smaller diameter to the workings, tubes of 1 or 1¼ inch caliber bringing it to the cylinder of the machine. This compressed air, when set free at each alternating stroke of the piston, imparts to the adjacent portions of the mine a pure, dry, cool atmosphere, from a well-known law of all air and gases, that when compressed they develop heat, and when expanded under a relaxation of pressure, they are relatively cool.

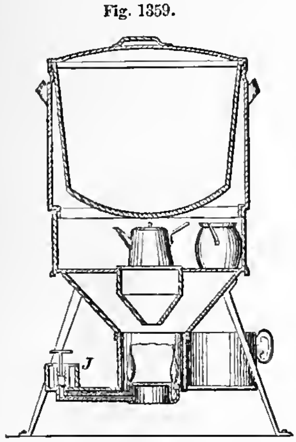
The machine is supported by a cast-metal frame of great solidity, and is of a size and weight proportioned to the character of the coal to be cut. It is constructed to give the blow of the pick, either by the pull or push of the piston.

The engine has an oscillating cylinder which has the merit of combining compactness of shape with but little complication of working parts. The machine rests upon flanged wheels and is propelled either backward or forward by a wheel and screw on a rachet and pinion, attached to one side of the engine. On the opposite side is a valve-screw for regulating by the hand the access of air to the engine. When working, the man seated upon the little stool in the rear of it moves the rachet-screw connected with the gearing of the under-carriage, and thereby propels the whole machine along the little railway or tram laid parallel to the front of the coal-seam, a small distance equal to the longitudinal nip or bite of the pick.

One machine, working 90 blows of the pick per minute, discharges, of condensed air, about 100 cubic feet per minute, which immediately becomes 300 cubic feet of cold air at the normal density, and each machine is competent to supply from 12 to 15 per cent of the ventilation required at the heading; the air being perfectly fresh, pure, and cool, and afforded precisely at the localities where the workmen are most in need of such an atmosphere. When working at 120 picks per minute, the machine cuts an inch at each stroke, 20 inches deep, 2½ inches wide; a second traverse deepens it to 30 inches, and a third to 36 inches.

Coal-oil Stove. One specifically adapted to cook or heat by means of coal-oil lamps. In the illustration, the burner is annular, and has a circle of wicks, the amount of oil being regulated by a screw-valve *J*. The parts of the stove are a hot-plate for cooking vessels, and a chamber above which may have an oven or a clothes-boiler.

Fig. 1359.



Coal-Oil Stove.

Coal-sack. A rough and strong bag, of hemp or jute, generally tarred, and used for conveying coals.

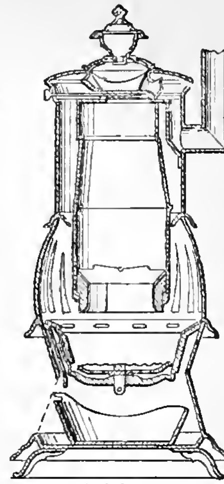
With the United States *portable* or *mountain* forge there is furnished a leathern coal-sack. It is 14 inches in diameter by 18 inches in hight, and of cylindrical shape.

Coal-screen. A sifter for coal. At the mines it is a very large eylinder with an inclined axis and portions of varying meshes, so as to sort the broken coal into sizes.

Coal-scut'tle. A box or hod for holding coals for present use.

Coal-stove. A stove for heating or cooking, adapted for the consumption of stone coal, as distinguished from charcoal or wood. The heating-stove is of many varieties, as the *magazine*, see Fig. 1360; the *cooking-stove; fireplace heater*, etc. See list under STOVES and HEATING APPLIANCES.

Fig. 1360



Coal-Stove.

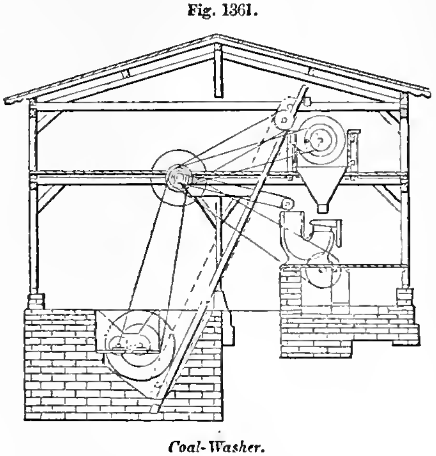
Coal-tongs. A pair of tongs for grasping coal in lumps. *Fire-tongs.*

Coal-wash'er. A machine in which coal which has been broken and assorted is finally washed to deprive it of the dust and dirt adhering. See COAL-BREAKER.

In some operations it is worth while to sort, clean, and use certain portions of the fuel which have passed through the furnace. In Fig. 1361, the coal, ashes, and cinders are ground, washed, and elevated into a drum, where the material is assorted by fineness and passed to the shaking-machine, where the qualities are separated according to gravity.

Coam'ings. (*Shipbuilding.*) The raised border or frame of a hatchway, to prevent the water on the deck from flowing below. *Combings.*

Fig. 1361.



Coal-Washer.

The fore and aft pieces of a hatchway frame are *coamings*, those athwart ship are *head-ledges*. The former rest on *carlings*, which extend from beam to beam, and the latter rest on the deck beams.

Co-ap'ta-tor. (*Surgery.*) An apparatus for fitting together the ends of a fractured bone and holding them in position while the bony junction is proceeding.

Coarse-stuff. (*Plastering.*) The first coat of inside plaster-work. It is composed of common lime mortar, as made for brick masonry, with a small quantity of hair; or by volumes, lime paste, 1 part; sand, 2 to 2½ parts; hair, ⅛ part.

Coast'er. A vessel employed in trading voyages from port to port, along a given coast.

Coat. 1. (*Nautical.*) A piece of tarred canvas, put about the masts at the partners, the rudder-casing, and also around the pumps, where they go through the upper deck, in order to prevent water passing down.

2. A layer of plaster or paint.

Of plastering : —

A *scratch-coat* is the first of three coats ; when laid upon laths it is from $\frac{1}{4}$ to $\frac{3}{8}$ of an inch in thickness.

One-coat work is plastering in one coat without finish, either on masoury or laths — that is, *rendered* or *laid.*

Two-coat work is plastering in two coats, done either in a *laying-coat* and *set*, or in a *screed-coat* and *set.*

Screed-coat ; a coat laid even with the edges of the screeds.

Floated coat ; a first coat, laid on with a float.

Slipped-coat is the smoothing off of a brown coat with a small quantity of lime putty, mixed with 3 per cent of white sand, so as to make a comparatively even surface.

Coat'ing Met'als with Met'als. See GILDING ; PLATING ; ELECTRO-PLATING ; SILVERING ; GALVANIZING ; PLATINIZING ; etc. For list see METALLURGY ; METAL-WORKING.

Coat-link. A pair of buttons joined by a link, for holding together the lappels of a double-breasted coat.

Co'balt. Equivalent, 29.5 ; symbol, Co. ; specific gravity, 8.92. A reddish-gray metal. Fusing-point about 2800° F.

Oxide of cobalt gives the blue color to glass. This glass broken into fragments forms *smalt.*

Cob. 1. (*Mining.*) To break ore with a hammer to reduce its size, to enable its separation from portions of the gangue, and its assortment into grades of quality.

2 An unburned brick.

Cob'le. (*Nautical.*) A small fishing-boat, of great antiquity in the British Islands. *Cogg'e.*

Cob'ler. A bent rasp for straightening the shaft of a ramrod.

Co'bourg-cloth. (*Fabric.*) A lady's dress goods, cotton-chain, woolen-filling, twilled on one side. It may be considered an imitation of merino.

Cob-wall. A wall built up solid of a compost of puddled clay and straw, or of straw, lime, and earth.

Cob'web-mi-crom'e-ter. Invented by Ramsden (1735 – 1800). A micrometer in which cobwebs are substituted for wires. By turning the screw which approximates or separates the frames across which the cobweb-threads are stretched, the slightest alterations of the lines can be estimated, and a difference, even of $\frac{1}{100000}$ of an inch be rendered appreciable.

Coch'le-a. 1. An ancient term for an engine of spiral form. The screw whereby Archimedes launched the great galley of Hiero is also called *cochlea* by Athenæus. A *screw-jack.*

2. A spiral pump for raising water, as introduced by Archimedes into Egypt. The *Archimedean screw.*

Cock. 1. (*Horology.*) A bridge-piece fastened at one end to a watch-plate or block, and at the other end forming a bearing for a pivot ; of the balance, for instance.

When the piece is supported at both ends, it is a *bridge.*

In *Lepine* watches, the wheels are pivoted in bridges instead of full plates.

2. The hammer of a gun-lock.

3. The gnomon or style of a dial. It represents the axis of the earth. It stands in the plane of the meridian, and its angle with the horizon is the latitude of the place. Mercutio may have referred to this when he made that very exceptionable remark to the nurse.

4. A faucet or rotary valve, usually taking its name from its peculiar use or construction, as: —

Blow-off cock.	Self-closing cock.
Cylinder-cock.	Steam-cock.
Feed-cock.	Stop-cock.
Four-way cock.	Three-way cock.
Gage-cock.	Try-cock.
Oil-cock.	Water-cock, etc., etc.

5. A vane.

6. A small boat.

7. A pile of hay. A cocking-machine gathers hay from the swath or windrow and puts it in cock.

8. The pointer of a balance.

Cock-bill. (*Nautical.*) An anchor is a cock-bill when it is suspended vertically from the cat-head. See ANCHOR, page 96.

Cock'et-cen'ter-ing. One in which head-room is left beneath the arch above the *springing-line.* Where passage beneath the arch is not required during the execution of the work, a *cocket-centering* is not needed, but the centering is constructed on a level tie-beam resting on the imposts.

Cock-eye. 1. (*Milling.*) A cavity on the under-side of the balance-rynd to receive the point of the spindle.

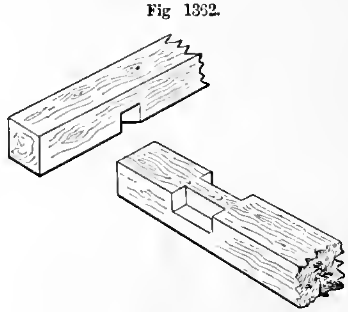
2. (*Saddlery.*) An iron loop on the end of a trace, adapted to catch over the pin on the end of a single-tree.

Originally *woodcock eye*, from the fancied resemblance of the thing to the head of the woodcock, the loop answering to the eye of the bird.

Cock-head. The upper point of a mill-stone spindle.

Cock'ing. (*Carpentry.*) *a.* A mode of fixing

Fig 1362.



Cocking.

the end of a tie-beam or floor-joist to a beam, girder, or wall-plate. *Cogging.*

b. Mortising.

Cock'le. 1. The hemispherical dome on the crown of a heating-furnace. See HEATING-STOVE.

2. A hop-drying kiln. An *oast.*

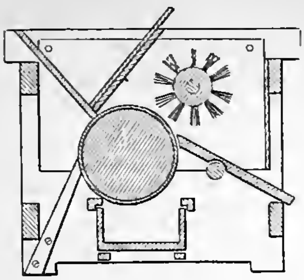
3. To buckle, or contract into wrinkles.

4. (*Porcelain.*) A large drying-stove used in a house where biscuit-ware dipped in *glaze* is dried preparatory to *firing.*

Cock'le and Gar'lic Sep'a-ra'tor. A machine for separating from wheat or other grain the seeds of cockle and the corms of the wild garlic, which is such a nuisance in some portions of the Atlantic slope.

In the example, the hopper has a small adjustable outlet through which the grain falls on to the perforated cylinder and is carried round and swept on the board by the revolving brush. The cockle drops

Fig. 1363.



Cockle and Garlic Separator.

through the perforations into the cylinder, and is carried round till it is discharged at the end into a drawer. Another mode of separating cockle and garlic is to give the roller a slightly adhesive surface, so that the rough-skinned cockle or the soft-skinned garlic may adhere thereto, and be carried off by the roller to be swept away, while the hard and bright-skinned grain refuses to adhere, and passes to a different receptacle.

Cock'le-stairs. (*Carpentry.*) Winding stairs.

Cock-met'al. An inferior alloy of copper and lead for making faucets. See ALLOY.

Cock-pit. (*Nautical.*) The after-part of the orlop deck. It is below the water-line and ordinarily forms quarters for junior officers, and in action is devoted to the surgeon and his patients.

Cock-spur. (*Pottery.*) A small piece of pottery used to place between two pieces of glazed-ware in the *saggar*, to prevent their adherence during the process of baking. *Stilts; triangles.*

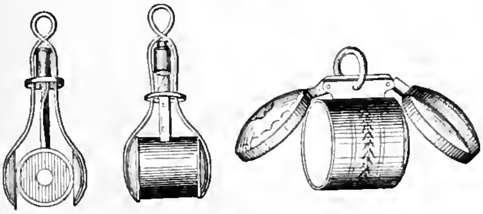
Cock-up Let'ter. (*Printing.*) A large letter standing above its fellows in the line, and formerly used for the initial letter of a book or chapter.

Co'coa. A palm (*Cocos nucifera*) from which the nut is derived. It also affords *coir*, from which ropes are made.

The name of the kernel from which the beverages cacao, broma, and chocolate are prepared, is sometimes corruptly spelt *cocoa*. See CACAO.

Cod'ding-ton Lens. A lens of spherical form having a deep equatorial groove around it in the plane of a great circle perpendicular as to the axis of vision. The groove is of such a depth that the stem

Fig. 1364.



Coddington Lens.

connecting the hemispheres has a diameter equal to $\frac{1}{3}$ of the focal length of the lens. This lens was invented by Dr. Wollaston, and called by him the *periscopic* lens; he made it by cementing together by their plane faces two hemispherical lenses with an annular, opaque diaphragm between them. Sir David Brewster improved it by cutting a groove in a whole sphere and filling the groove with opaque matter in order to diminish the quantity of light and prevent the confusion arising from the lateral rays.

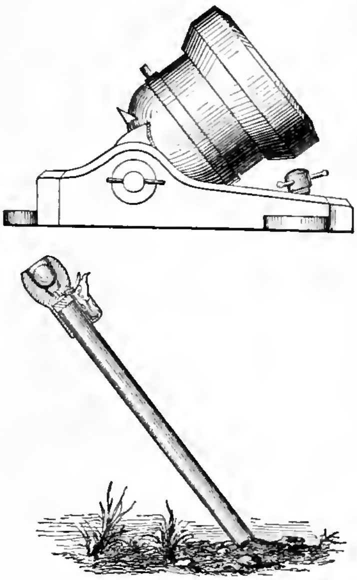
Cod-line. An 18-thread deep-sea fishing-line.

Cod'ling. A balk sawed into lengths for staves. It is cleft or *rived* into staves by means of a *frow* and *mallet.*

Coe'horn. (*Ordnance.*) A small mortar made light enough to be carried by hand, and adapted to throw a shell to a small distance. Used in fortifications and for signaling. The name is derived from its inventor, the Dutch Engineer officer, Coehorn, who was Director General of the fortifications of the United Provinces of Holland.

The regulation Coehorn mortar in the United States Service, is of brass, weighs 160 pounds, 24-pdr. caliber. It is mounted on a wooden bed having four handles by which it is carried by as many men.

Fig. 1365.



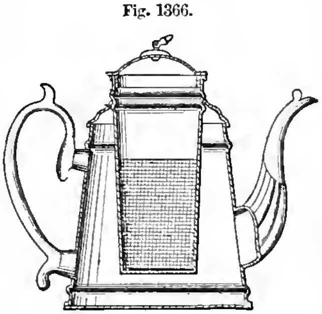
Coehorns.

The English coehorn has a bore of $4\frac{1}{2}$ inches, a length of 12 inches, and weighs, with bed, about 340 pounds.

Goodwin's coehorn is fixed on a stake and fired by a trigger and lanyard. It is a surprisingly effective little piece, throwing a three-inch shell to a great distance, and may be carried, one under each arm.

Cof'fee-big'gin. A coffee-pot with a bag to contain the ground coffee through which the boiling water is poured. The wire strainer is a substitute for the flannel bag.

Fig. 1366.



Coffee-Biggin.

Cof'fee-clean'ing Ma-chine'. A machine resembling a *bran-duster* or *smut* machine, in which the coffee grains are *beaten, rubbed, brushed,* and *winnowed* to remove the "parchment," or thin adhering envelope of the grain, and also purge it of dust and foreign matter. The devices are numerous, but generally consist of rotating beaters, rubbing surfaces, fans, etc.

Newell's patents, 1857 and 1859, may be taken as a type. A steam-heated cylinder, wire-gauze cylindrical envelope, rotating beaters.

Following these are about sixteen patents.

The object of some is to clean the grain; of others to "produce a yellow, brown, or golden color, to increase the commercial value."

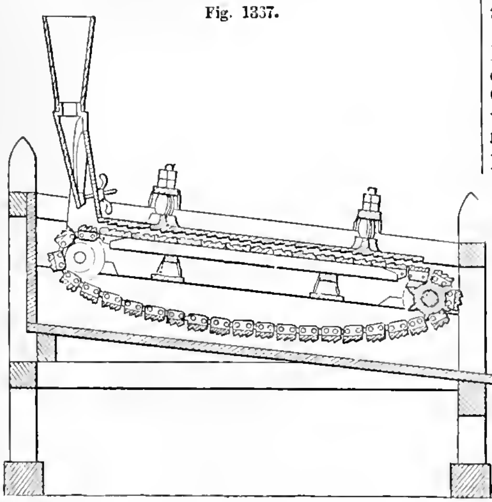
Sand and talc-dust are used by some to rasp the grain.

Cof'fee-hull'er. A machine to remove the husk or sac which covers the coffee-grains. It consists of an arrangement of serrated surfaces on a belt, or reciprocated past other serrated surfaces, between which the envelope is torn and loosened from the grain. Subsequent rubbing, brushing, dusting, and winnowing complete the process of hulling.

The *coffee cleaner* and *polisher* operates upon the grain subsequently.

The machine is similar to a rice-huller. Ditson's patent, 1835, has abrading surfaces made by perforating sheet-iron. See also Adams's patent, 1836.

Fig. 1367.



Coffee-Huller.

Subsequent to these are about ten others, which have certain peculiarities of construction. In the example, the husk is removed from the coffee while passing between the serrated blocks of the endless belt, and the serrated lower surface of the yielding plate.

Cof'fee-ma-chin'er-y. Coffee, as picked from the tree, looks like cherries, and is treated in Ceylon in the following manner:—

The berries are laid in heaps on the floor, whence they pass to the *pulpers*. These remove the flesh and skin, *sarcocarp* and *epicarp*, leaving two beans in a sac. The *pulper* is a stout frame supporting a fly-wheel, shaft, and barrel. The latter is of sheet-copper, punched from the inside so as to expose a grating surface to the fruit, which is fed on to it from a hopper and passes between the barrel and a chock, which forms a throat. The pulp passes off, while the beans in their envelope fall into a box beneath and are placed in cisterns where they are covered with water for twelve hours or so, in order to slightly ferment the mucilage which covers the membrane and prevent its hardening upon the skin.

After washing, it is placed on the *barbecues*, which are circular stone structures with polished plaster surfaces on which the beans are sunned for four days, while yet remaining in their envelope. It is thus dried sufficiently to be sent to Kandy, and thence to Columbo, where it undergoes a final treatment, consisting of curing, removing the covering, and picking out faulty berries.

In some establishments the beans are cured by a blast of warm dry air introduced into a chamber beneath the berries.

Cof'fee-mill. A small hand-mill in which roasted coffee-berries are ground by passing between the serrated surfaces of opposed steel disks or rollers, or roller and concave, as the case may be.

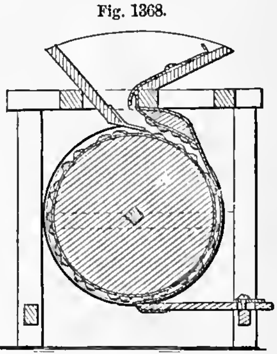
Coffee is the berry of the *Coffea Arabica*, a shrub of the order *rubiaceæ*, and its fruit resembles the cherry. Bruce says that it is native in Abyssinia. The use of the infusion as a beverage cannot be traced back very far. It was carried by Selim from Egypt to Constantinople, but does not appear to have been publicly sold till 1554. Its use was forbidden by the mufti, but again permitted by an edict of Solyman the Great. The Venetians brought it from the Levant in 1615, and in 1645 it was introduced into Marseilles.

Coffee was introduced into England by Daniel Edwards, a Turkey merchant, in 1657. The first coffee-house in England was in St. Michael's Alley, Cornhill, London; opened by Pasqua, a Greek servant of Mr. Edwards. It was then sold at from four to five guineas a pound. Coffee-trees were imported from Mocha by the Dutch about 1700, and thence carried to Surinam. In 1714 a coffee-plant was presented by the magistrates of Amsterdam to Louis XIV., and placed in the grounds at Marly. The progeny of this plant were carried to Cayenne and Martinique. In two centuries its use spread all over the civilized world.

The coffee-tree does not thrive where the temperature ever sinks below 55° F. It grows to the hight of 12 or 15 feet, has a leaf like the laurel, but not so thick. The blossoms are white, like the jessamine, and issue from the axillæ of the leaf-stalks. When they fade they are succeeded by the berry, which, as said before, resembles a cherry, is red when ripe, and has a yellowish, glutinous pulp, enclosing a sac containing two seeds.

Cof'fee-pol'ish-er. A machine for removing traces of mildew and stain from coffee as imported, or the effects of damp or heating in store. In the example, the coffee is discharged from the hopper upon the rim of a cylinder, covered with elastic material, and carried between the crushing plate or rubber and knobbed belt. The crushing plate is hinged and held in position by an elastic belt, the end of which is secured to an adjustable stretcher.

Fig. 1368.



Coffee-Polisher.

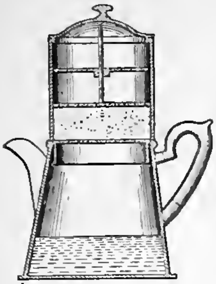
Cof'fee-pot. A vessel in which the infusion of coffee is made. Of the various kinds may be cited:—

1. The *percolator*, in which the infusion passes from the infusion-vessel through a strainer into a reservoir. This is effected by simple filtration, by pressure of steam, or by producing a partial vacuum.

The *percolator* was invented by Count Rumford.

The ground coffee is pressed between perforated diaphragms, so as by compactness to prevent the water from filtering through too quickly.

Fig. 1339.



Rumford's Percolator.

2. Coffee-pots having arrangements for condensing the steam and the essential oil, — which constitutes the aroma of the coffee, — and returning them to the infusion. An early arrangement of this kind is the Bencini patent, September 27, 1838. See also Martell's patent, 1825; Rowland, 1844; Waite and Sener, "Old Dominion," 1856. These have lids or upper chambers to condense the steam.

3. Coffee-pots of peculiar construction, as: —

Hotte, 1870; a furnace inside the coffee-pot.

Manning, 1869; an earthenware lining to a metallic pot.

Gibson, 1871; a flat breast to prevent lateral tilting when the pot is tipped forward.

Suspended on journals over a lamp and tipped on its bearings.

A strainer suspended from the spout.

Hot-water jacket.

Iron heater in reservoir; the urn.

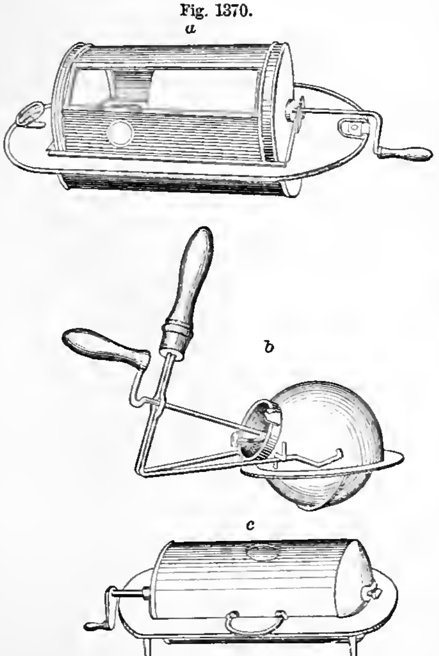
Divided chambers for tea and coffee, or coffee and water.

A piston to compress the ground and expel the infusion.

A piston to eject water in desired quantities from the water reservoir into the infusion.

Various arrangements of coffee-pots, of lamp-heated pots, and urns, may be seen in Webster and Parkes's "Encyclopedia of Domestic Economy," London, 1852, pp. 711–716.

Fig. 1370.



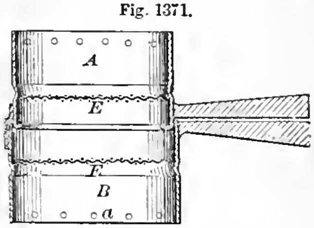
Coffee-Roasters.

Cof'fee-pulp'er. A machine for treating the coffee fruit by removing the pulp and the envelope of the seeds. See COFFEE-MACHINERY.

Cof'fee-roast'er. Two objects are attempted to be secured in coffee-roasters: to keep the berries moving and prevent their burning, and to keep the aroma confined as much as possible. The aroma depends upon the essential oil in the berry, and the empyreumatic flavor is developed by heat; or the oil is developed in the berry in the process of decomposition.

The coffee-roaster is generally of a cylindrical or prismatic form, and is rotated on a horizontal axis by means of a crank. In Fig. 1370, *a*, the base-plate is made to fit into the hole in a stove-top made by removing a pair of stove-lids and the center-plate between them, a protecting sheet beneath preventing the direct action of the fire upon the cylinder which rotates in journals above. The axial stud at each end is eccentric, those on the respective ends being on alternate sides of the center, so as to give a tumbling motion to the coffee, which is thus shaken from end to end of the cylinder as well as from side to side.

Fig. 1371.



Coffee-Roaster.

A glass pane or slip allows the state of the process to be observed. The chamber is a polygonal prism, the plates forming the sides being more effective in tumbling the berries than are the smooth surfaces of a cylinder.

b (Fig. 1370) has a spherical chamber which occupies a stove-hole, and is revolved by the crank-handle while held in place by the other handle.

c is a cylinder mounted in a plate with legs.

Law's *coffee-roaster* (English) is a hollow sphere having a compound motion, revolving continuously in a horizontal plane and intermittingly in a vertical plane. URE, 1. 456.

Fig. 1371 has two cylinders *A B* with wire-gauze diaphragms *E E* hinged together and held closed by their handles. The coffee is contained between the foraminous diaphragms. The roaster is reversible, and sits upon the stove-top over a pot-hole.

Cof'fer. 1. (*Architecture.*) A sunk panel in a soffit or ceiling, deeply recessed by one or more separate faces, having the appearance of inverted steps, and enriched with moldings in the several internal angles, and with roses in the center.

2. (*Fortification.*) A hollow work across a dry moat to aid in repulsing a storming party by enfilade fire.

3. (*Hydraulic Engineering.*) A canal-lock chamber.

4. A large wooden vessel with movable ends to receive a barge or other vessel. A floating dock.

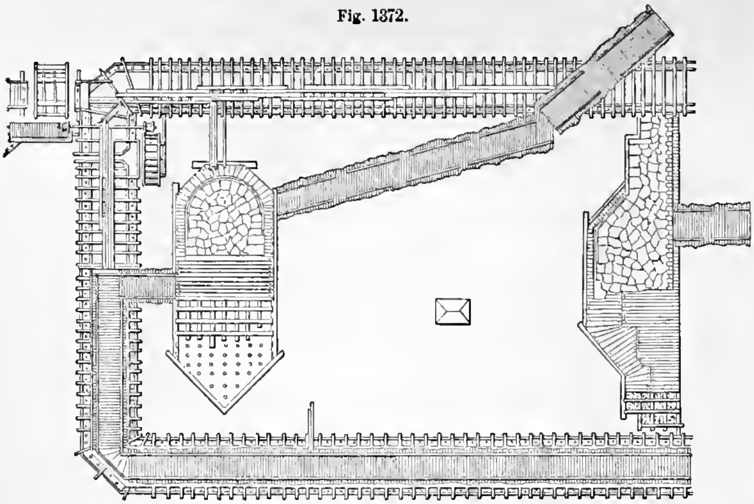
5. A casket for jewels.

6. A store-chest for muniments.

Cof'fer-dam. (*Hydraulic Engineering.*) A water-tight enclosure formed by piles driven into the bottom of a river and packed by clay, planks, or other stop-gap. It is used as a dam while laying bare the bottom of the river, in order to establish a foundation for a pier, abutment, or quay.

Peronnet's coffer-dams at the bridges of Mantes and Neuilly were made of two rows of piles, which were iron-shod, and driven with a monkey weighing 1,000 pounds. The mud was removed from the in-

Fig. 1372.



Peronnet's Coffer-Dam.

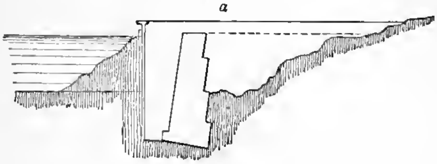
outside being protected with clay and an artificial bank *a*, Fig. 1373.

A sectional view *b*, Fig. 1374, will give a clear idea of the double wall of piles, between which the puddle is rammed to form a water-tight filling.

Instead of forming a double wall of piles in this manner, it has been suggested to dredge out the mud enclosed by the outer wall of circumvallation, then fill to a certain hight with *béton*. Upon this as a basis, an inner circle of shorter piles is driven, and the space between the walls puddled. The interior enclosure is then pumped out.

tervening space by means of dredging-machines and the space filled with clay, rammed down. The water from the interior of the dam was then pumped out.

Fig. 1373.

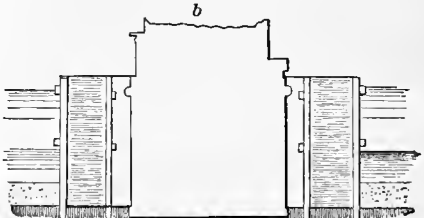


Coffer-Dam.

In shallow water and in situations but little exposed, a single row of piles sometimes suffices, the

The pier coffer-dam of London Bridge (Fig. 1375) is described at length in Cresy. It is elliptical in

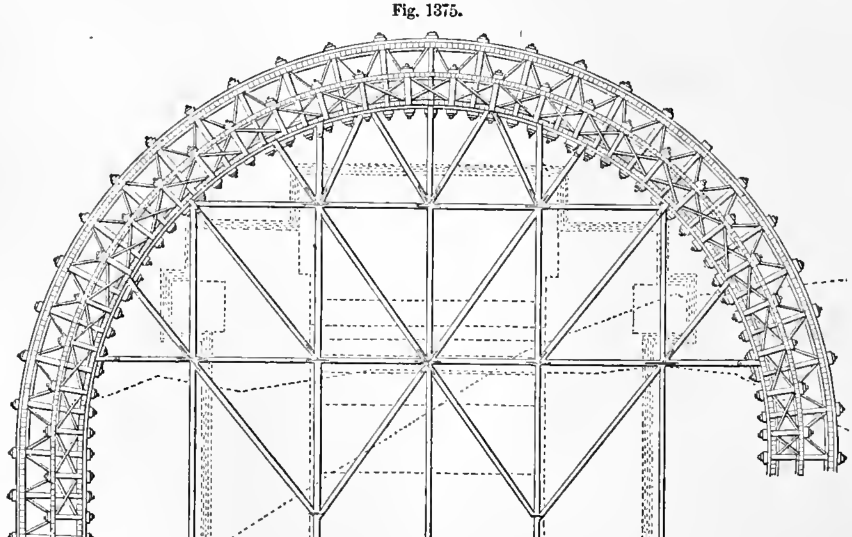
Fig. 1374.



Coffer-Dam.

form, and a portion of it is shown in plan in the figure. It was composed of piles not less than 12½

Fig. 1375.



Coffer-Dam of London Bridge.

inches square, driven in rows and braced by timbers and tie-bolts. The outer row and sheet walings and the spaces between rows were plugged with clay, the joints calked and covered with pitch. The piles were straightened, planed on the edges, and shod.

A coffer-dam built by the government engineers engaged in improving the navigation of the Mississippi River over the rapids of Rock Island is four thousand six hundred feet, or seven eighths of a mile long. It runs parallel with the shore, is from eight to fourteen feet wide, and near one million feet of lumber were used in its construction.

Cof'fer-ing. (*Mining.*) Securing a shaft from leaking by ramming in clay. See CAISSON; CURB.

Cof'fer-work. (*Masonry.*) Rubble-work faced with stone. See MASONRY.

Cof'fin. 1. (*Mining.*) *a.* A mode of working, *open to grass*, in which the bed of ore is uncovered by casting up the ore and attle by stall-boards, from one to another, to the surface.

b. An old exposed working.

2. (*Printing.*) The wooden frame inclosing the imposing-stone.

3. A receptacle to hold a corpse. A burial-case.

Joseph was put in a coffin in Egypt (Gen. l. 26), about 1650 B. C. This is the only mention of a coffin in the Bible; that mode of burial was never common among the Israelites, but Joseph's body was embalmed and coffined, according to the custom of his adopted country, and was taken out of Egypt by his countrymen when they left for Canaan, 1491 B. C.

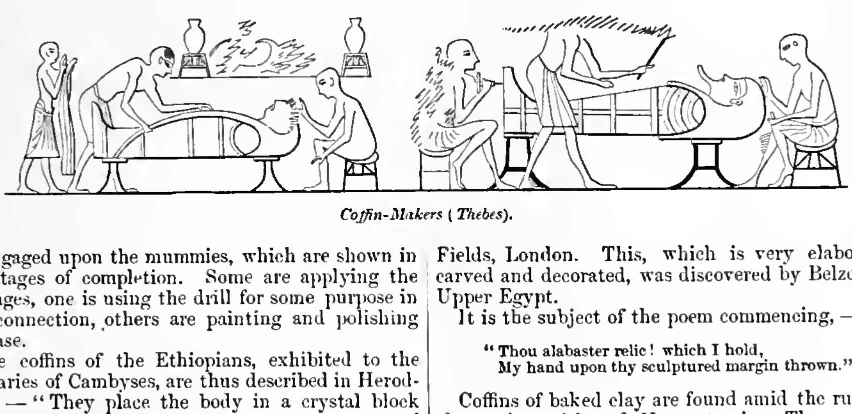
The coffins of ancient Egypt were frequently stained to represent rare and foreign woods. The sycamore was the principal wood used, and it was handsomely painted, inlaid, and carved, according to their peculiar ideas and taste.

It must be admitted that Egypt has the palm of priority and skill in the subject of coffins. They had a good reason for exercising so much care, as they believed that in due time the spirit would return to the body, and they desired to keep it in the best order possible. We have no room to go into the subject of embalming, but may say, that the brain and viscera were withdrawn, the former at the nostrils, and the latter at incisions made by flint knives in the side of the abdomen. The cavities were then stuffed and the body bandaged, resinous and aromatic substances being employed to arrest decay. A box received the body and its wrapping, and the lid was tightly closed. The style of ornamentation can be best gathered by inspection of the mummies, or some of the beautiful volumes written by men who have made the subject a study. The work of the French professors, "Description de l'Egypte," made under the auspices of Napoleon, and Wilkinson's work on the manners and customs of the ancient Egyptians, will afford the best information extant, in book form.

The embalming process of the most expensive kind cost about a talent of silver, over $1,000 of our money. The processes were graded in price according to the ability of the survivors, the pecuniosity of the estate, or the ante-mortem directions of the defunct.

The illustration annexed is from a Theban tomb, exhibiting the trade of a coffin-maker. The men

Fig. 1376.



Coffin-Makers (Thebes).

are engaged upon the mummies, which are shown in two stages of completion. Some are applying the bandages, one is using the drill for some purpose in this connection, others are painting and polishing the case.

The coffins of the Ethiopians, exhibited to the emissaries of Cambyses, are thus described in Herodotus: — "They place the body in a crystal block which has been hollowed out to receive it, crystal being dug up in great abundance in their country, and of a kind very easy to work. You may see the corpse through the block in which it lies, and it neither gives out any unpleasant odor, nor is it in any respect unseemly; yet there is no part which is not as plainly visible as if the body was bare."

Book III., chapter 24, he speaks of the body being dried, and painted in imitation of health before inhumation; and of a corpse being treated as one of the family for a year after death, meals and attentions being scrupulously offered thereto.

The substance described as having been hollowed out for the reception of the mummy may have been glass, which was known in Egypt previous to this period, or it may have been the *lapis specularis*, or one form of gypsum.

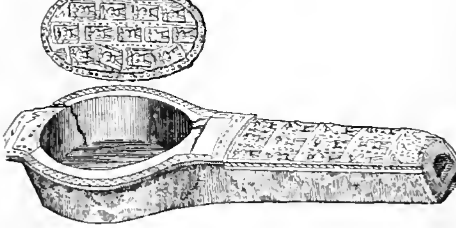
A sarcophagus of alabaster was (in 1845) in the museum of the late Sir John Soane, Lincoln's-Inn Fields, London. This, which is very elaborately carved and decorated, was discovered by Belzoni, in Upper Egypt.

It is the subject of the poem commencing, —

> "Thou alabaster relic! which I hold,
> My hand upon thy sculptured margin thrown."

Coffins of baked clay are found amid the ruins of the ancient cities of Mesopotamia. They are occasionally of wood. A common form of burial among the Hamite Chaldeans was to lay the body

Fig. 1377.



Parthian Coffin.

on a brick platform and then cover it with a dome of pottery, like a modern dish-cover.

Coffins from Warka, of green glazed pottery and shaped like a slipper-bath (see Fig. 1377), belonged probably to the Chaldeans of the Parthian age.

One sarcophagus of a Scythian king entombed at Kertch was found to be of yew wood, and had two compartments; one for the body, the other for weapons. The sarcophagus was in a large stone vault which contained the skeletons of a wife, an attendant, a horse, and divers jars, which probably once held provisions. It is pictured in Rawlinson's Herodotus, note to pp. 49, 50, Vol. III. (Am. ed.).

Sarcophagi of terra cotta, ornamented in bas-relief and with recumbent statues of the deceased, are found in the British Museum. See article "*Funus*," in Smith's "Dictionary of Greek and Roman Antiquities."

Glass coffins were patented in England in 1847. Unfortunately they were also used by the Egyptians over 2,000 years ago.

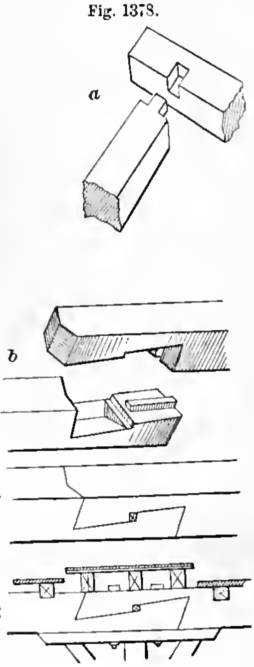
We learn from Pliny that Varro and others directed that their bodies, when dead, should be deposited in earthenware.

Coffins made of slate slabs united by metallic corner-pieces and bolts are described in an 1868 patent.

Coffins are rendered impervious to moisture by resins, asphaltum, paraffine, etc.

A Danish paper states that Herr Woerman, ship-owner of Hamburg, has been commissioned to procure a coffin for his present Majesty the King Jberio, on the West coast of Africa. The coffin is of fir-wood, polished on the outside, and furnished very comfortably. It is lined with red velvet, and has soft velvet cushions. There are five glass windows in the lid to let the light enter, and under it is placed a mirror for aid to reflection. The handles and feet are of tin, as well as the window settings; and, lastly, the coffin arrangement is completed by two bottles of gin and the necessary glasses. The prospect of death is rendered cheerful by the continual presence of the box in his Majesty's state apartments.

Fig. 1378.



Cogs.

4. (*Milling.*) One of the sockets in the eye of the runner, which receives the ends of the driver.

The term is applied to other depressions, especially to such as are hollowed or chipped out.

Cof'fin-gage. An instrument, cross-shaped, with graduated stem, head-piece, and arms, by which the measurement of a corpse may be readily made.

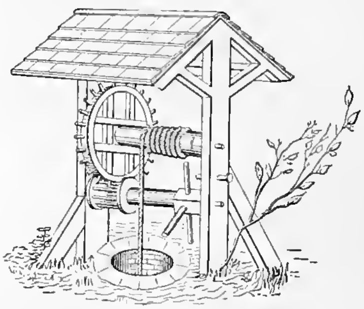
Cog. 1. A tooth, cam, catch or lifter, which acts upon an object to move it; as in the case of a gear-wheel; the wiper on the shaft which lifts a trip-hammer, or the pestle of a stamp-mill; the projection from the arbor of a stop-motion, or from a disk in a register or feed motion, etc.

2. (*Carpentry.*) *a.* A projecting piece *a* on the end of a joist, which is in the nature of a tenon, and is received into a notch in a bearing timber, such as a wall-plate, the cog resting flush with the upper surface of the plate.

b. A longitudinal tenon *b c d* projecting from one of the faces of a scarf-joint and entering a recess in the face of the other timber, to prevent lateral deflection of the scarf-joint. A *coak.*

Cog and Round. An old-fashioned bucket-hoist having a *cog*-wheel and lantern, the latter having staves or *rounds.*

Fig. 1379.



Cog and Round.

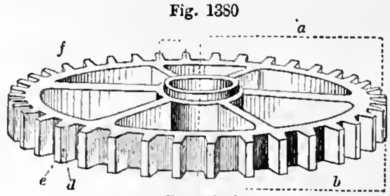
Cog-wear. An old-time narrow frieze goods, of coarse quality.

Cog-wheel. One having teeth which mash into similar ones on another wheel to impart motion thereto, or to receive it therefrom. The name — *cog* — shows the original mode of construction, in which *cogs* or pieces of wood were inserted into mortises in the face of a wheel. Wheels thus constructed are used under the names of *rag* or *sprocket* wheels, in connection with chains or *lantern* wheels, the latter having *rounds* or *rundles* between disks.

The teeth of cog-wheels are now usually made solid with the rim, being cast therewith or cut thereupon.

There are numerous varieties of cog-wheels, known by peculiar shapes, modes of presentation of the wheel, or by special features of the teeth. A list is given under GEARING (which see).

Fig. 1380



Cog-Wheel.

A *spur*-wheel has cogs projecting radially, either inward or outward.

A *crown* or *contrate* wheel has cogs projecting from the rim parallel with the axis.

A *bevel* or *miter* wheel has teeth whose faces are oblique with the axis.

The *pinion* bears a specific relation to a larger cog-wheel.

For list of cog-wheels, see GEARING.

In the illustration a *spur*-wheel is shown, the cogs being radial.

The characteristic parts of the wheel are as follows: —

a, primitive or *geometric radius;* distance of the center of the wheel from the *pitch-line.*

b, true (or *real*) *radius;* distance of center of wheel from extremity of cog.

The *addendum* is the difference between the real and geometric radius.

Interdental space; the interval between cogs.

The *pitch c* of a wheel is the distance measured along the pitch-line from the center of one tooth to the center of the next.

The *pitch-surface* of a wheel is an ideal smooth surface, intermediate between the crests of the teeth and the bottoms of the interdental spaces, which, by rolling contact with the pitch-surface of another wheel, would communicate the same velocity-ratio that the teeth communicate by their sliding contact.

The *pitch-line* of a wheel, or, in circular wheels, the *pitch-circle*, is a transverse section of the *pitch-surface* made by a surface perpendicular to it and to the axis; that is, in *spur*-wheels, by a plane perpendicular to the axis; in *bevel*-wheels, by a sphere described about the apex of the conical pitch-surface; and in *skew-bevel* wheels, by any oblate spheroid generated by the rotation of an ellipse whose foci are the same with those of the hyperbola that generates the pitch surface. (RANKIN.)

The *pitch-point* of a pair of wheels is the point of contact of their pitch-lines.

The *crest* of a cog is its extreme outer surface.

The *face e* of a cog is the acting surface beyond the pitch-line. *f* is the shoulder.

The *flank d* lies within the pitch-surface.

The substitution of the iron for the wooden wheel is originally due to Smeaton, who introduced iron wheels at Carron, in Great Britain, in 1754, and at Belper, Derbyshire, shortly after. A cast-iron bevel-wheel was also used in Scotland about the same time by Mr. W. Murdock. Not until 1784, however, was cast-iron fairly introduced in the various details of mill work, and the credit of this wider application of the improvement belongs to John Rennie, an eminent and successful engineer, who adopted it for bevel and spur wheels at Boulton and Watt's, at the Soho Rolling Mill and Foundry.

Cog-wheels were formerly distinguished from toothed wheels by the former having teeth of different materials from, and inserted into, the rim. This distinction is not now very usual.

Coil. 1. A helix or spiral; the word is used to indicate variously convolved forms.

It seems proper that the term "coil" should be considered generic, including both the helical and spiral forms.

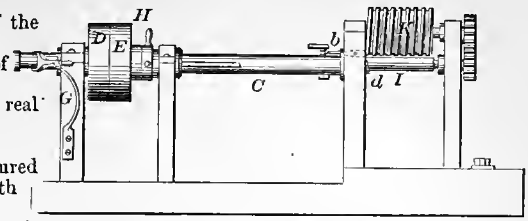
Helical, appertaining to a *helix*, which is a coil decreasing in radius as it approaches the center; whether in the same plane as a coil of rope, or a watch-spring, or assuming a conical shape, as with *helixes* of shells.

Spiral, shaped like a wire wound upon a cylinder; as the spring of the chronometer, the spring-balance, etc. The coils have the same diameter.

2. (*Nautical.*) Rope laid up ring fashion, *fake* on *fake*. When laid up in a flat helix, without riders, beginning in the middle, and "with the sun," it is said to be a Flemish coil.

Coiled-spring. A metallic spring laid up in a spiral so as to have a resiliency in the line of its axis, either by extension or condensation, as the spring may be arranged. Fig. 1381 shows one mode of coiling springs in which the wire is wound on a revolving mandrel, the end being held by a sliding sleeve and locking dog. The wire is coiled upon

Fig. 1381.



Machine for coiling Springs.

the mandrel *I* as it rotates, by a spirally grooved cylinder *K*. The coil is stripped from the mandrel by the longitudinal movement of the latter.

The uses of such springs are so numerous that it will be impossible to enumerate a large proportion of them. Springs for railway cars, spring-balances, bed-bottoms, etc. See Fig. 1143, page 483.

Coin. A piece of metal on which certain characters are stamped by authority, giving the piece a legal current value.

No coin has been found of the ancient Egyptians or Assyrians; neither do the Phœnicians appear to have coined money.

The money of ancient Egypt was in the form of rings, which were of gold and silver, *a b c d*, fig. 1382. The same currency, we learn from Wilkinson, is in use in Senaar and the neighboring countries. The Egyptians had no coin till the time of Alexander, 330 B. C., except a few of the Persian, and some made in imitation, which cost the viceroy his life.

The Chinese and Japanese have also ring-money.

Money was originally estimated by weight, as in the case of the sum paid for a piece of land by Abraham to Ephron the Hittite, and the money "in full weight" found in the corn-sacks of Joseph's brethren. In the Theban paintings, the public weigher is shown in the act of weighing money. See BALANCE.

To avoid the trouble of weighing the metal whenever a purchase was made, or of cutting it to make fractions, pieces of a known weight were ready cut and introduced into circulation. These were marked with their weight; afterwards devices, such as the name or figure of the king, were placed upon them to confer authenticity, and thus coins were established.

Chinese bronze and copper money was made as early as 1100 B. C., but none of gold or silver till a much later period.

The brass money referred to by Homer as existing 1184 B. C. was bronze, and may have been merely pieces of known weight. Herodotus states that the Lydians first coined money about 1000 B. C. This was at the period when Solomon paid Hiram in corn, wine, and oil, for the use of his skilled workmen and his cedar-wood.

The early coins of Lydia show a punch-mark on the reverse, the *quadratum incisum*, given by a protuberance on the anvil upon which the planchet of metal was laid to receive the impression of the die, which was laid above and struck by a hammer. The punch-mark on the reverse was afterwards converted into a regular impression in intaglio. The lion device of Lydia was probably adopted on coins by Crœsus; other Lydian coins have the archer, which was copied on the Persian *daric*.

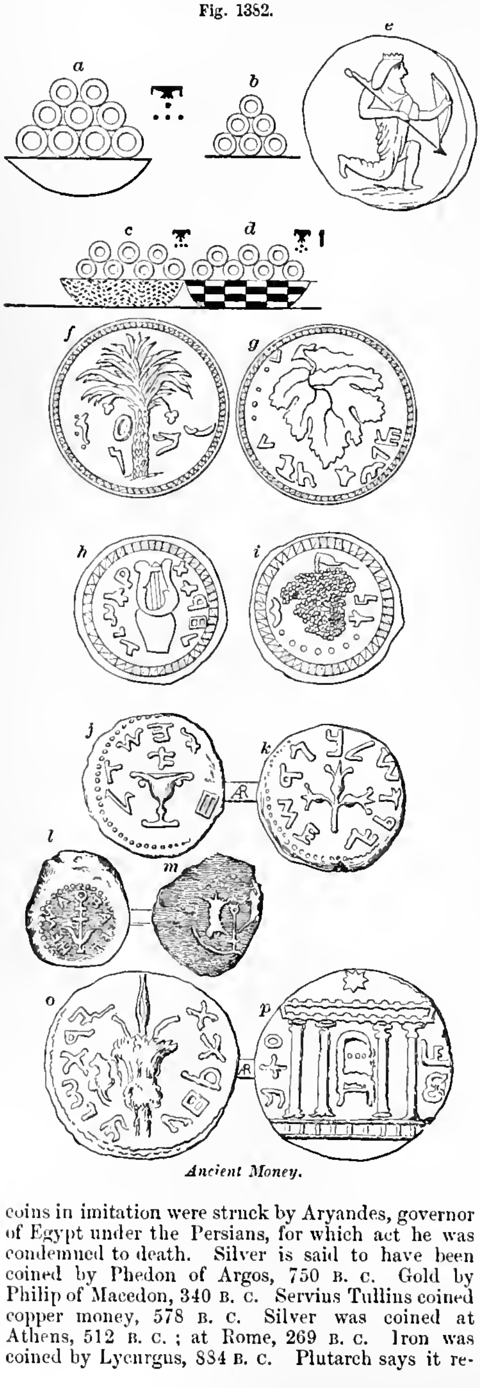
The different states of Greece adopted various animals for emblems.

The earliest representations of the human form, designed as portraits, are the Macedonian series, commencing with Alexander, the son of Amyntas.

One form of Greek money, before the introduction of coin, was in *skewers*, of which six formed a *handfu'*.

An early gold coin was the Persian darlic *e*, Fig. 1382, which weighed about 130 grains troy. Silver

Fig. 1382.



Ancient Money.

coins in imitation were struck by Aryandes, governor of Egypt under the Persians, for which act he was condemned to death. Silver is said to have been coined by Phedon of Argos, 750 B. C. Gold by Philip of Macedon, 340 B. C. Servius Tullius coined copper money, 578 B. C. Silver was coined at Athens, 512 B. C.; at Rome, 269 B. C. Iron was coined by Lycurgus, 884 B. C. Plutarch says it required a cart and two oxen to draw the small sum of 10 minæ, about $28.

It is said that the coin of Philip of Macedon was the first that was alloyed; it was done to harden it, and make it wear better.

Coined money was first cited in those portions of the Hebrew Scriptures written after the captivity. The Jews had no coined money of their own till the time of the Maccabees, when King Antiochus gave leave to Simon to "coin money for his country with his own stamp." (1 Maccabees xv. 6.)

The money mentioned by Ezra was probably the Persian daric *e*, Fig. 1382, equal to about $5.50. Cyrus paid the soldiers of Clearchus a daric a month. (XENOPHON.)

The Jewish silver shekel had a weight of about half an ounce, and value about 62 cents of our money. To form an idea of the economic value of money, do not forget to consider the relative value of provisions.

f g are the obverse and reverse of the shekel.

h i the obverse and reverse of the half-shekel.

j is an obverse with the inscription, "Shekel of Israel."

k the reverse of the same coin, with "Jerusalem the Holy," and a vase having three flowers.

The coins of Herod are of copper or brass, and are abundant, numismatically speaking. The obverse *l* has an inscription and anchor; the reverse *m* has two cornucopiæ, within which is a caduceus.

The *shekel*, *stater*, *drachma*, and *denarius*, representing three different nationalities, were current in Palestine.

Barkabah, who raised a politico-religious crusade against the Romans in the time of Hadrian, closed the series of Jewish coins (*o p*), for after this Jerusalem, as a Jewish city, disappears altogether, and under the name of Ælia, A. D. 135, became a Roman colony from which Jews were rigorously excluded. Constantine restored the name and made it a Christian city about A. D. 326. Five centuries of peace, a long period for Jerusalem, followed the restoration under Constantine and Julian. Then followed the Persian, Chosroes II., A. D. 614; Heraclius retrieved it in 628; but Omar subdued it, A. D. 637. The Christians regained it but for a brief and bloody interval of 87 years, in the eleventh and twelfth centuries, when it was conquered by Saladin, became nominally attached to the Kingdom of Sicily in 1277, and in 1517 passed under the sway of the Ottoman Sultan, Selim I., whose successor Suliman built the present walls of the city in 1542.

The stamping of metal to form coin was originally performed by a common punch, by a succession of blows, making a rude impression, more or less perfect, according to the skill of the workman. An instance of this is an early silver coin of Ægina with the emblematical tortoise.

The *stater*, the principal gold coin of ancient Greece, was, perhaps, the earliest coin, and the mode of its manufacture was characteristic of coinage for a long period. The obverse has a rude image of a lion's head, and the reverse has an indentation. A single die was used, and the piece of metal placed on it; a punch drove the metal into the intaglio of the die, and the marks of the punch remained on the reverse.

The first improvement upon this consisted in placing a device on the face of the punch, giving a design to the reverse in intaglio. This was not, in the first place, similar to the cameo relief of the obverse, as may be seen in the quarter-stater of Phocea. Then followed a coinage in which the obverse and reverse showed the same design, — one in relief and the other in intaglio. The next step was evidently to make two dies with intaglio faces, between which the planchet or piece of metal was swaged so as to give the design in relief on each side. To this we still adhere.

The first designs on coin were emblematical or else indicative of weight, that is, value. The emblems were various, as in the case of the tortoise of Ægina, or the owl of Athens, and were afterwards supplanted by figures or heads of deities, who presided over the destinies of the respective countries or cities.

The silver coin of Alexander I., of Macedonia, 450 B. C., is said to have been the first which had a representation of the human figure; and the drachma of Archelaus, 413 B. C., the first coin with a portrait. This practice was not adopted by the Romans till the time of Julius Cæsar, when it became general, and is yet practiced, as is well known. The Mohammedans, in their detestation of images, inscribe the name and title of the prince, and on the reverse the name of the coin and the year of the Hegira. The crescent, found on some Byzantine coins, was adopted as a symbol by the Turks.

"King Abderahman (Ben Moavia) had his zeka, or house for the coinage of money, in Cordova; he introduced no change in the currency, but retained the dies used in Syria by the Caliphs, who were his predecessors, and made his coins in all respects similar to theirs, . . . excepting what was necessitated by time and place." — CONDÈ.

Justinian II. was the first who had the image of Christ struck on coins, A. D. 710. The Pope's effigy first occurs on a coin in 1480.

The *as libra*, in the time of Servius Tullius (550 B. C.), weighed a pound, as its name indicates; by 190 B. C., it had fallen to half an ounce. Silver was coined 269 B. C., when the denarius weighed 90 grains; in the time of Vespasian, A. D. 70, it had fallen to 53 grains. The aureus was first issued about 204 B. C., and weighed 166 grains, but had fallen to 96 grains in the time of Heliogabalus, A. D. 218.

The silver coinage of Crotona, 600 B. C., was pure, as was also the gold coinage of Philip of Macedon, 350 B. C. Under Vespasian, A. D. 79, the silver money contained one fourth its weight of copper. Under Antoninus Pius, A. D. 138, more than one third. Under Commodus, A. D. 180, nearly one half. Under Gordian, A. D. 236, more than two thirds of the so-called silver coin was copper. Under Gallienus, A. D. 361, a coinage was issued, an alloy of copper, tin, and silver, of which the latter formed less than a two hundredth part. The Republic debased the coin by reducing its weight, the Empire by alloying it.

Pieces of copper and of tin, of known weight but irregular shape, were used in Britain, till Cunobelin, King of the Trinobantes, who had been educated at the court of Augustus, imitated the Roman coin; but under Claudius the British mint was destroyed, the Roman coin introduced, and continued in circulation till the arrival of the Saxons.

Assaying in England originated with the Bishop of Salisbury, treasurer to Henry I., about 1130. It was practiced by the Romans.

In the reign of Edward I. the penny was so deeply indented with a cross that it was easily divided into half-pence and fourthlings (farthings).

Henry III. issued the first gold coin in England, 1257. Edward III. issued gold coin in 1344, and at that time the armorial bearings appear on British coins.

Pounds sterling, crowns, and shillings were issued by Henry VIII., half-crowns and sixpences by Edward VI. The guinea, so called from being made of African gold, was issued in 1663, and stamped with an elephant. The name "sovereign" (English pound sterling) was of later date, reign of James I. The screw-press was invented by Bucher, a Frenchman, in 1553, and was established in the English mint in 1602. The edge was grained at first to prevent clipping. A motto was placed on the edge in 1651.

The first coin or medal with milled edges is said to be that of George Frederick, Marquis of Brandenburgh, 1589.

The "angel," value 6s. 8d., first coined A. D. 1430. The obverse represented Michael the Archangel with his left foot on the dragon.

The first government copper coinage in England was in 1620. Copper tokens had been issued previously by corporations and individuals.

"At my goldsmith's did observe the king's (Charles II.) new medall, where, in little, there is Mrs. Stewart's [afterwards Duchess of Richmond] face, as well done as ever I saw anything in my whole life, I think; and a pretty thing it is that he should choose her face to represent Britannia by." — PEPYS'S *Diary*, Feb. 25, 1667.

The alloy (English) of gold is silver and copper, and of silver, is copper. English standard gold is 22 carats gold to 2 of alloy. Standard silver is 11 oz. 2 dwts. silver, to 18 dwts. copper. The American gold coin is 36 parts gold, 3 parts copper, 1 part silver.

The American and French silver coin are 9 parts silver, 1 part copper. See STANDARD.

The proper weight of the double-eagle is 516 troy grains, and the smaller gold coins in proportion. The law permits a variation above or below the standard of half a grain. See REMEDY.

The series of operations in coining is as follows:—

1. The ingot is assayed and alloyed.
2. A number of ingots melted into a long, flat bar.
3. The bar is repeatedly rolled, cut into pieces, annealed, and re-rolled until it assumes the shape of a ribbon, approximating the width and thickness of the required coin.
4. The ribbon is *drawn* through a gage to bring it to exact size.
5. The ribbon is cut into blanks, each planchet being of the weight, and approximately the size, of the coin.
6. The planchet is tested by an automatic weighing-machine, which rejects heavy and light, and selects those of proper weight.
7. The edge of the planchet is *milled*, that is, rolled smooth and circular and slightly turned over.
8. The *planchet* is heated, cooled in water, cleansed in acidulated water, and then dried in hot sawdust.
9. The *blank* is stamped between the die and counter-die, the *nurling* being done at the same operation.

Coin-as-sort'er. A machine which separates different kinds of coins by size, or coins of the same kind by weight.

In one form of the first mentioned, the coins are put singly into a hopper and fed edgeways to the inclined way, in which they roll upon their edges and lean toward the open side of the way, so as to drop out on arriving at an aperture large enough therefor. The distance between the holding lips of the guides constantly increases, so that the coins will drop out at different places, each into its appropriate tube. The tubes are marked by a scale, to indicate the number of coins by the depth of the pile.

In another form, the coins pass into a graduated series of rotary cylindrical sifters or sorting-barrels, with internal spiral divisions, causing the coins to travel through and between each spiral thread ; circular openings allow all the coins except the largest to drop through. The largest coins are delivered into a till, but the remainder pass through other barrels, until only the smallest ones remain.

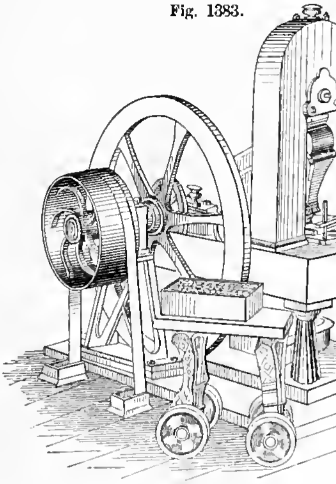
In machines for sorting gold or silver coin into full-weights and light-weights, the scales are arranged so that the coin of full weight in a lower position is pushed off by an automatic pusher into one box, but the light-weights are lifted a little higher by the rising of the scale, and are brought opposite to another pusher which sends them into a light-weight box.

Coin-count'er. An arrangement by which the process of hand counting, piece by piece, is dispensed with. A shovel or tray has shallow depressions of a given length, width, and depth to hold so many coins of a given kind. The coins are shoveled into the tray, which is then skillfully agitated until the coins have snugly occupied all the spaces. The remainder are brushed off, and the complete quota is thrown into a scale to verify the count by weighing.

Coin'ing-press. A power lever-screw press by which the planchet of metal is impressed with the design or legend.

The blanks are placed in a tube at the front of the press, and at each motion the lower blank in the pile is seized by fingers and drawn into a collar between the upper and lower dies ; where as the lever descends, the two arms of the toggle-joints are

Fig. 1383.



Coining-Press.

brought into line perpendicularly, imparting a powerful pressure to the blank, causing it to fill out the collar and forming at the same time the face and obverse impressions, as well as the flutings or nurling on its edge.

The piece is then released by the relaxation of the toggle-joint allowing the upper die to rise ; the lower die rises sufficiently to discharge the coin from the collar, and the fingers, returning with a second blank, push the first out and allow it to slide into a box below. The coins are then examined to detect defective pieces, as flaws sometimes occur from air-bubbles in the original cast ingots ; and, after being counted by means of a special apparatus for the purpose, are placed in bags.

The lower die is on what is termed the *die-stake*, and gives the reverse impression. The obverse is in the upper die.

The pressure in coining double-eagles is about 75 tons.

Coin-weigh'ing Ma-chine'. A machine for weighing coin and assorting them according to their *full* or *light* weight.

The gold coins are placed in a pile, and the bottom one is shifted by a slide along a channel just large enough for the standard gold coin, but too large for a counterfeit, and is deposited on the scale supported by a knife-edge upon the beam. The forceps, which temporarily detain the weight-scale, are then let go, and if the coin be light that end of the beam will rise and the other end leaves the agate point which rests upon it ; a bolt then advances and pushes off the coin into a light-weight receptacle. If the coin be full weight, the scale remains down ; the lower bolt knocks it off into a full-weight box at a lower level ; the position of the coin at a lower or a higher elevation determines which of the bolts shall strike it, and at which eduction aperture it shall depart.

Coir. The prepared fiber of the husk or pericarp of the cocoa-nut, which is made into rope, matting, brushes, etc.

The nut is picked a little before it is ripe, and the pericarp stripped from the nut by forcing it upon an iron stake fixed in the ground. The rind is then soaked in water for several months to soften the substance which fills the interstices between the fibers. It is then beaten upon a stone with a heavy piece of wood, and then rubbed by the hands. Forty cocoa-nuts yield six pounds of *coir*.

The operation of twisting it into yarn is similar to that pursued with hemp.

Coir cordage is lighter than hemp, is pliable, and has a strength, compared with hempen rope, of 87 to 108 with large rope, and 60 to 65 with small rope.

It is well adapted for hawsers, as it is light enough to float in sea-water, and also for running-rigging, but is not so well adapted for standing-rigging, owing to its contractibility.

Coir is also made from the long, fibrous, black, cloth-like covering of the *Borassus gonnutus*.

Coke. Charred pitcoal.

It is carbonized in heaps, in ovens, or in the retorts of the gas manufactory. It may be remarked that the production of the best coke and the best gas from the same coal is incompatible ; the bulk of the mass is increased by coking, the weight diminished from 30 to 55 per cent, according to the mode of conducting the process.

As the distillation of wood leaves a solid residue of charcoal, so is coke the residue of the distillation of coal. 2,240 pounds, a long ton, of bituminous coal is said to yield 8,000 to 10,000 cubic feet of carbureted hydrogen gas, and 1,100 to 1,300 pounds of dry, brittle coke.

Sir John Hacket and Octavius de Strada proposed in 1626 to convert coal into coke, and thus make it as agreeable a fuel for chambers as wood or charcoal.

In 1658 the project was revived by Sir John Winter, who constructed a fire-cage 11 inches high, and a box below with an ash-pit door, which was opened when the fire was to be urged.

The manufacture of coke in heaps is thus managed : —

An oblong square hearth is prepared by beating the earth to a firm, flat surface, and puddling it over with clay. The pieces of coal are then piled up on this, leaning against each other, and each with its acutest angle resting on the hearth. The piles are from 30 to 50 inches high, 9 to 16 feet broad, and contain from 40 to 100 tons of coal. A number of vents are left, reaching from top to bottom, into which the burning fuel is thrown, and they are then closed with small pieces of coal beaten in hard. The fire creeps along the bottom, rises gradually and equally, and bursts out on every side at once. If the coal contain pyrites, the combustion is allowed to proceed a considerable time after the disappearance of the smoke, to extricate the sulphur. If it contain no sulphur, the fire is covered up soon after the smoke disappears, beginning at the bottom and proceeding gradually to the top. In from fifty to seventy hours the heap is covered completely, and in from twelve to fourteen days the coke is ready for removal.

The coke of gas-works is obtained from the charred coal, withdrawn from the retorts and quenched with water.

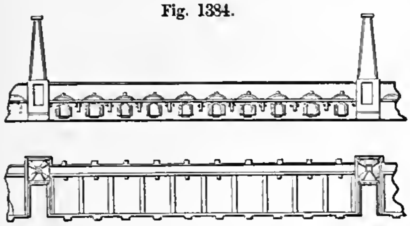
Coke-fur'nace. A furnace in which the volatile matters are expelled from pit-coal, leaving a residual carbon which burns without flame and makes an intense heat. A *coke-oven.*

Coke-ov'en. An oven in which the gas is expelled from coal, leaving the coke or carbonaceous portion.

A heap of coal enclosed with earth so as to limit the access of air, and provided with small holes to allow the escape of gases, may be fired and will produce coke. Coke-ovens are similar in principle, and have openings above for charging with coal, openings below for withdrawing the coke, and means for graduating the admission of air.

When made on a large scale, a number of large ovens are placed in a row, and a railway is laid

Fig. 1384.



Coke-Oven.

along the top for the coal-cars, which dump their contents into the ovens. A lower railway affords a track for the cars which receive the coke from the ovens.

The coke-ovens of the London and Birmingham Railroad are eighteen in a series, with flues at the back leading to a chimney 11 feet internal diameter, wall 3 feet thick at the base, 115 feet high.

Each oven is elliptical, about 11 × 12 feet. The charge is 6,720 pounds. Forty hours suffice for the coking. It is then withdrawn and watered. The loss in weight, 20 per cent. It gains one quarter in bulk.

Col'an-der. A strainer formed of perforated sheet-metal.

The *colum* or colander of the Greeks and Romans was used for straining the must from the pulp and skins of the grapes; the oil from the *amurca*; and for domestic purposes. They were made of perforated bronze or silver; of hair, broom (*spartium*), or rushes.

Several were found at Pompeii.

A beautiful bronze colander was exhumed near Heliopolis, and is in the Abbott collection. The holes are drilled in small patterns. It has a handle.

The colander for pouring lead in the making of shot is a hollow hemisphere of sheet-iron, about 10 inches in diameter, and perforated with holes which are free from burs.

The holes have nearly the following diameters for the annexed sizes of shot: —

No. 0	$\frac{1}{50}$	of an inch.
1	$\frac{1}{58}$	"
2	$\frac{1}{66}$	"
3	$\frac{1}{72}$	"
4	$\frac{1}{80}$	"

by gradations to No. 9, which is $\frac{1}{360}$ "

Instead of a *colander*, an oblong ladle is now used in some towers, the edge being scalloped to break the overflow into small streams.

Col'an-der-shov'el. One of wire open-work, for shoveling salt crystals out of the evaporating-pan.

Col'ar-in. (*Architecture.*) The space, frequently ornamented, between the astragal and the annulets of the capital of the Tuscan or Roman doric column.

Col'co-thar. A red oxide of iron, obtained by the calcination of sulphate of iron, and used for polishing. See CROCUS; GRINDING MATERIALS.

Cold-blast. (*Metallurgy.*) Air forced into a smelting-furnace, at a natural temperature, in contradistinction to a heated blast, which is more economical, but produces an inferior quality of iron.

Cold-chis'el. A steel tool used for cutting metals, and driven by the blows of a hammer.

Cold-drawn. Oil expressed from seeds or nuts without previous heating of the latter, is said to be *cold* drawn; and is of superior quality to that yielded by previously heated seeds or nuts.

Cold-ham'mer-ing. The hammering of a metal, without fire-heat, to give hardness and temper.

Cold-short. (*Founding.*) A void or seam in a casting occasioned by the too rapid congelation of the metal which failed to fill the mold perfectly.

Cold-short Iron. Iron containing phosphorous, which may be forged and welded while hot, but is brittle when cold.

Cold-shut. A term meaning that a link is closed while cold, without welding.

Cold-wa'ter Pump. (*Steam-engine.*) A pump by which the condenser cistern is supplied with cold water.

Col'lar. 1. (*Machinery.*) A ring or round flange upon or against an object. Its purpose may be: —

A. To restrain a motion within given limits, as: —

a. The *collar* or *butting-ring* on an axle, which limits the motion inward of the hub on the axle.

b. The ring shrunk upon, or an annular projection or enlargement of a shaft or rod which keeps it from slipping endwise.

c. A short sleeve on a shaft.

d. The neck of a bolt.

B. To hold an object in place; as: —

a. The plate of metal screwed down upon the stuffing-box of a steam or pump cylinder, and having a hole through which the piston passes.

b. The ring inserted in a lathe puppet for holding the end of the mandrel next the chuck, in order to make the spindle run truly.

2. (*Engineering.*) The curb or steining around the top of a shaft to restrain the friable superficial strata and to keep loose matters from falling in.

3. (*Nautical.*) An eye formed in a bight of a shroud or rope, to pass over a mast-head, to hold a dead-eye or a block, or for other analogous purposes.

4. (*Harness.*) A roll of leather stuffed with straw, etc., and having two creases to hold the

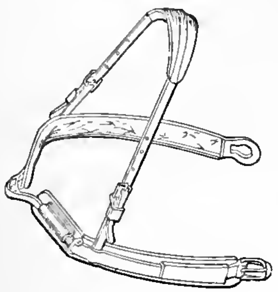
hames. It is placed around the neck of the horse, fits against the shoulders, and forms the bearing against which the horse presses in drawing the load.

The parts of the collar are: —

The *withers;* the upper bow resting on the neck of the horse.

The *after-wale, body-side,* or *pad;* the portion behind the hames.

Fig. 1385.



Breast-Collar.

The *fore-wale,* or *small roll.*

The *housing;* a covering to shed rain from the collar and shoulder.

The *collar-strap;* at the upper end.

The *breast-collar,* so called, is a breast-strap, forming a substitute for a collar.

5. (*Architecture.*) *a.* A ring or cincture. An astragal.

b. A beam staying two opposite rafters at a point between the comb and the plates. See COLLAR-BEAM.

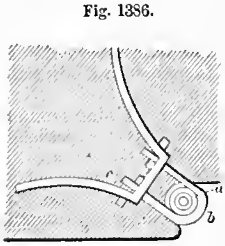
6. (*Coining.*) A steel ring which confines a planchet and prevents lateral spreading under the pressure or blows of the coining-press. When the edge of the coin is to be lettered, the letters are sunk in the collar, which is in three pieces, confined by an outer ring.

7. (*Clothing.*) A band around the neck, or the neck portion of a body garment. Shirt-collars, or what are made to appear as such, are made of paper, paper and cloth combined, cloth, leather, metal. They are made reversible, are embossed in imitation of lace, linen, stitching; printed in imitation of various kinds of figured goods; stained to resemble certain kinds of fabrics. Paper collars are made combined with bosoms or with neck-ties, or both, with peculiar fastenings or with reinforced button-holes.

Their manufacture involves machines for cutting, punching, folding, molding, shaping, embossing, planishing, burnishing, and boxing.

The process of making paper collars is briefly as follows: — Sheets of paper, preferably 16 × 36 inches and weighing 125 pounds to the ream, are enameled, dried, embossed to imitate cloth by roller pressure between plates on which cloth has been tightly stretched and pasted. The sheets are polished by revolving brushes; cut in heaps of eighty thicknesses by steel dies of the shape required; reinforced by patches of fabric at the button-holes; the button-holes cut, stitches impressed on the border, and the size stamped on them. The collar is molded to fit the neck, rolled up in dozens, so called, but more often only ten; put in a box, labeled and cased.

Fig. 1386.



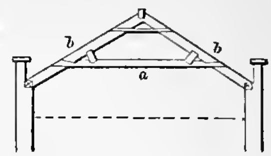
Collar and Clamp.

Col'lar and Clamp. The ordinary form of dock-gate hinge. Also known as *anchor and collar.* The anchor *c* is let into the masonry, and the collar is formed by a clevis *b,* whose legs are secured by fore-locks in the clamp. *a* is the hole for the pintle of the leaf.

Col'lar-awl. (*Saddlery.*) A form in which the eye-pointed needle has been used for many years. It is used in sewing collars, the wax-end being passed through the material by its means, and drawn tightly by the hands.

Col'lar-beam. A tie-beam *a* uniting the breasts of a pair of rafters *b b,* to keep them from sagging or spreading. It acts as a strut, a tie, and often as a ceiling joist for a garret story.

Fig. 1387.



Collar-Beam.

Col'lar-block. (*Saddlery.*) The harness-maker's block on which a collar is shaped and sewn.

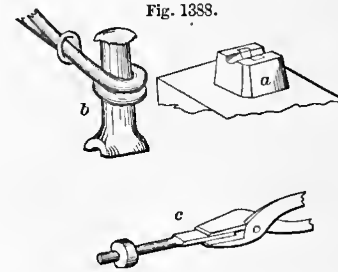
Col'lar-check. A heavy woolen goods made for saddlery purposes.

Col'lar-har'ness. Harness with a collar in contradistinction to *breast-harness.*

Col'lar-plate. An auxiliary puppet, or midway rest in a lathe for turning long pieces.

Col'lar-tool. (*Forging.*) A rounding tool for the formation of collars or flanges on rods by a process of swaging.

Fig. 1388.



Collar Tools.

a represents the lower half of the tool in the *hardy-hole* of the anvil.

b is the upper or *fullering* tool.

c shows the collar and rod in the grip of the pinchers.

Col-lect'ing-bot'tle. A microscopist's tank for collecting and retaining objects dipped from ponds. The funnel *c* fits in the tube *a* when the cover of the latter is removed. The tube *b* has a cover of fine muslin.

Fig 1389.

Collecting-Bottle.

Col'let. 1. (*Machinery.*) A small band of metal; as the ring which fastens the packing of a piston.

2. (*Jewelry.*) *a.* The part of a ring containing the *bezel* in which the stone is set.

b. The flat surface which terminates the *culasse* or lower faceted portion of a *brilliant-cut* diamond. It is sometimes called the lower table or culet, and is one fifth of the size of the upper one.

Coll'ier. (*Nautical.*) A vessel employed in carrying coals by sea.

Col-li-ma'tor. A telescope arranged and used to determine errors of collimation, both vertical and horizontal. (NICHOL.) A collimating eye-piece has a diagonal reflector for illumination, and is used to determine the error of collimation in a transit instrument, by observing the image of a cross-wire reflected from mercury, and comparing its position in the field with that of the same wire seen directly.

The error of collimation is the deviation of the line of collimation of an astronomical or geodetical instrument from its normal or correct position with respect to the axis of motion of the instrument. (WEBSTER.)

The floating and the vertical-floating collimator were invented by Captain Kater, and are two instruments of similar principle and of not very different construction, designed to facilitate the adjustment of circles. The former is used for determining the horizontal point, and the latter the zenith or nadir points, as the case may be. Each kind consists of a telescope (with a system of cross-wires in its field) which is made to rest in a horizontal position on a plate of iron floating on a surface of mercury; or is fixed vertically in a frame, at the lower part of which is an iron ring whose plane is at right angles to the axis of the telescope, the ring floating on mercury in an annular vessel. The telescope of the circle which it is desired to adjust being duly put in position, the observer looks through it, either upward or downward, as the case may be, to the telescope of the collimator, which, in the vertical instrument, is mounted with its axis coincident with the axis of the ring. The adjustment consists in bringing the cross-wires of the two telescopes to a mutual intersection by the screw movement of the circle. G. CHAMBERS.

Col'lish. (*Shoe-making.*) A tool to polish the edge of a sole.

Col-lo'di-o-chlo'ride Proc'ess. A photographic printing process invented by George H. Simpson, editor of the Photographic News, about 1863. It consists in holding in suspension a precipitate of chloride of silver in collodion, which is flowed upon glass or paper — in a manner similar to preparing a plate for the negative process — and dried in the dark. The sensitive surface so produced blackens on exposure to light, and will consequently give a picture under a photographic negative. An excess of free nitrate of silver is necessary to impart sensitiveness; an addition of citric acid and other organic substances is used to produce the desired tints. After exposure the picture is fixed and toned as usual.

Col-lo'di-on-proc'ess. A process in photography invented by Archer. An *iodized collodion* is made by impregnating a solution of gun-cotton in ether, with a small quantity of iodide of potassium or cadmium. A film of the iodized collodion is spread on the glass, which is then immersed in a solution of nitrate of silver. The image is taken in the camera, developed by a weak solution of pyrogallic acid and acetic acid, or a solution of protosulphate of iron. Excess of iodide of silver is removed by hyposulphite of soda or cyanide of potassium.

This gives a *negative*. A positive is obtained by laying the negative on prepared paper and exposing them to light.

Col-lo'di-o-type. (*Photography.*) Or collodion-process. A name applied to those processes in which a film of sensitized collodion is used on a plate in obtaining an image. In the *wet* collodion process the plate is exposed while moist; in the *dry* collodion process the plate is first dried.

The collodion *positives* are *melanotypes* and *ambrotypes*; the images are formed on the collodion, so as to be viewed by reflected or transmitted light. When viewed by reflected light they are termed *ambrotypes.*

Collodion *negatives* are obtained on a film of sensitized collodion on glass.

Col-lu'-vi-a'ri-um. An opening in an aqueduct to allow access for cleaning or repairs, and for ventillation.

Col'on-nade'. (*Architecture.*) A range of columns, whether attached or insulated, and supporting an entablature.

Co'lon. A punctuation mark (" : ") prescribing an interval greater than a semicolon.

Col'or-doc'tor. (*Calico-printing.*) *a.* A roller of gun-metal or steel pressed against the face of the engraved roll for calico-printing, and receiving a tremulous motion to slightly abrade the copper surface and enable it to hold the color more effectually.

b. A sharp-edged ruler of gun-metal presented at a tangent upon the engraved cylinder of the calico-printing machine. The *doctor* acts as a wiper to hold back superfluous color, and has a slight reciprocating motion in contact with the surface of the cylinder. A *lint-doctor* on the other or delivery side of the roller removes fibers of cotton from the cylinder.

Col'ored Fires. Compositions, generally based on powder or its components, used in pyrotechny for making various ornamental fire-works, known as *lances, stars, lights, wheel-fires, sun-fires*, etc.

Col'ored Light. A pyrotechnic display or signal for effect or preconcerted purpose. One formula for their composition is as follows: —

1. White light: 8 parts saltpeter, 2 parts sulphur, 2 parts antimony.
2. Red light: 20 parts nitrate of strontia, 5 parts chlorate of potash, 6½ parts sulphur, 1 part charcoal.
3. Blue light: 9 parts chlorate of potash, 3 parts sulphur, 3 parts mountain blue (carbonate of copper).
4. Yellow light: 24 parts nitrate of soda, 8 parts antimony, 6 parts sulphur, 1 part charcoal.
5. Green light: 20 parts nitrate of baryta, 18 parts chlorate of potash, 10 parts sulphur.
6. Violet light: 4 parts nitrate of strontia, 9 parts chlorate of potash, 5 parts sulphur, 1 part carbonate of copper, 1 part calomel.

Col'ored Glass. A glass used to interpose between the light and its illuminated field; used as a signal for railways and ships; also in lighthouses to give a marked peculiarity to the light by which it may be recognized; also for purposes of display.

Col'or-im'e-ter. A measurer of color. For various forms, see list under METER.

Col'or-print'ing. Printing by a succession of colors, or by various colors occupying parts of the sheet. There are various modes. See CHROMATIC PRINTING.

Co-los'sus. A statue of gigantic size.

The largest statue in Egypt, according to Diodorus Siculus, was that of Osymandyas, in the Ramesion. It is the Memnonium of Strabo. The pedestal is still standing; the court around is filled with its fragments. The foot, of which parts remain, must have been 11 feet long and 4 feet 10 inches broad; the breadth across the shoulders 22 feet 4 inches; the hight is calculated at 54 feet, the weight 1,985,438 pounds.

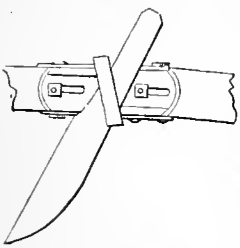
The statues of Memnon are 60 feet in hight, including the pedestal. The latter is 13 feet high, but is half buried in the alluvial soil. The material is a coarse, hard breccia, with imbedded chalcedonies. The southern figure is in one block. The northern one was broken before the Christian era, and was repaired with sandstone, in five pieces, by one of the Roman emperors, probably Severus.

The colossi of antiquity (Greek and Roman) are enumerated in Smith's "Dictionary of Greek and Roman Antiquities," p. 322.

Col-rake A shovel used to stir lead ores while being washed.

Colt'er. A knife or sharp-edged bar, usually secured to the beam, and projecting downward in front of the breast of a plow. Its duty is to make the incision in the soil in advance of the share, making a vertical cut the width of the furrow-slice which is to be cut below by the share and turned over by the mold-board. In the West it is usually termed a cutter, the term "colter" being applied to those which extend down in front of the share and have a depression in the rear to receive a lug on the point of the share, the colter being continued on in front to form the entering-point. The colter, in this case, is supported in the rear by the point of the share; in the ordinary mode the point of the colter projects into a notch on the upper edge of the share, and is supported thereby. Sometimes, instead of passing through a slot in the beam and being secured by a wedge, or being secured to the beam by a shackle, the colter is bent at right angles, and its shank slips into staples on the sheth, resting parallel with the upper edge of the land-side.

Fig 1390.

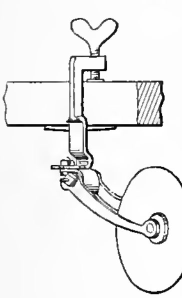


Colter.

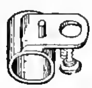
The ancient plow consisted of a beam and a colter, the latter doing all the work, instead of being merely subsidiary to the main working parts. The colter is not now considered a necessary part of most plows, except for plowing sod, when it is useful in cutting the roots and enables the plow to do clean work.

The word is from the Latin *culter*, a knife. Not all knives were known by that name, but a heavy description with a straight edge, curved back, and sharp point.

Fig. 1391.



Wheel-Colter.



In Fig. 1390 the colter is shown as secured by a side-bar and shackle. The wheel-colter in Fig. 1391 is mounted as a caster-wheel. It has long been employed in the fen lands of England.

Colt's Pis'tol. A revolving pistol first patented by Colt in 1835, and perfected in 1845. See REVOLVER.

Col'um-ba'ri-um. 1. A hole left in a wall for the insertion of the ends of a timber; named from its resemblance to a niche in a pigeon-house.

2. A niche in a mausoleum for a funereal urn was also so called.

Co-lum'bi-ad. An improved gun introduced by Colonel Bomford, of the Ordnance Corps, United States army, about 1812. It was made proportionately thicker at the breech and smaller at the muzzle than the guns theretofore in use, and was the precursor of the Paixhan gun of the French army (introduced in 1822), the Dahlgren, and the Rodman.

Co-lum'bi-er. A size of drawing-paper measuring $34\frac{1}{2} \times 23$ inches, and weighing 100 pounds to the ream.

Co-lum'bi-um. A rare metal, so named from having been first discovered in America. Now called *niobium*. Once called *tantalum*.

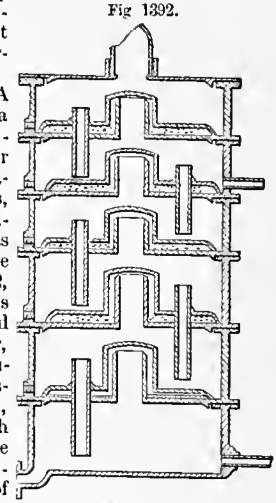
Col'umn. 1. (*Architecture.*) A vertical support of the nature of a pillar.

It usually has three members, — the *capital, shaft,* and *base*. The capital has an *abacus*, the base frequently a *plinth*.

Early Egyptian columns were fluted. The Ionic volute was from Persepolis. The Doric is Egyptian. The Corinthian is an improvement on the Egyptian. The pediment is Grecian, as are also all the fine and skillful proportions of parts. Ornamented architraves are from the land of the Nile. Figures for columns, resembling the Atlantes and Caryatides of the Greeks, are found in old Egypt.

2. (*Printing.*) A perpendicular set of type or printed lines; usually said of matter separated from another set or bounded by a vertical rule or line.

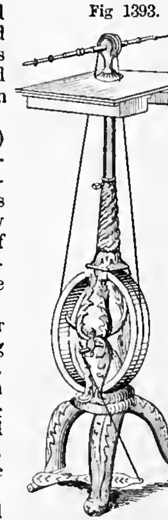
Fig 1392.



Still Column.

3. (*Distilling.*) A vessel containing a vertical series of chambers used in stills for continuous distillation; such as Coffey's, in which the two columns are known as the *analyzer* and the *rectifier*. In Fig. 1392, it consists of a series of chambers placed one above the other, the lower one communicating with the vessel. Steam is admitted, and passes up through the pipes into the chambers, being compelled, by means of hoods, to descend in its passage, and enter the chambers beneath the surface of the liquid contained therein. The chambers are partially filled from above with the liquid to be distilled, the pipes distributing the liquid from the top to the bottom chamber of the series.

Fig 1393.



Column-Lathe.

4. (*Calico-printing.*) The name of a certain description of steam apparatus by which steam is applied to cloths topically treated with a mixture of dye-extracts and mordants, in order to fix the colors.

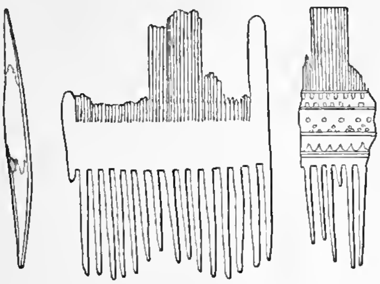
The *column* is a copper cylinder 44 inches long and 5 inches diameter, perforated with $\frac{1}{16}$th inch holes, at distances of $\frac{1}{4}$ inch. Round it are lapped a few folds of blanket, then of white calico; the goods are then wound on, the pieces being stitched together; over all are a few thicknesses of white calico. The *column* is then placed vertically, and the steam admitted to its inside is emitted through the holes, saturating the cloth and fixing the colors. The process takes twenty or thirty minutes.

Col'umn-lathe. A dentist's or watch-maker's lathe on a vertical extensible post to accommodate an operator in a sitting or standing posture.

Col'umn-rule. (*Printing.*) A brass slip to separate columns of type.

Comb. 1. (*Toilet.*) An instrument with a row of teeth for cleaning, straightening, and adjusting the hair.

Fig. 1394.



Egyptian Combs (Thebes).

The combs of ancient Egypt were made of wood or ivory, and generally double, one side having finer teeth than the other.

The Greeks had also combs with two rows of teeth like our fine-tooth combs. Such have been found in Pompeii. They and the Romans used combs (*pecten*) of boxwood from the shores of the Euxine.

The women of China wore ivory combs in the ninth century A. D. The comb of the Patagonians and Fuegians is the jaw of a porpoise.

Combs derive their names from purpose, form, or material, as: —

Back-comb.	Horn-comb.
Child's round-comb.	India rubber comb.
Dress-comb.	Ivory comb.
Fine-tooth comb.	Metal-backed comb.
Folding-comb.	Round-comb.
Gutta-percha comb.	Tortoise-shell comb.
Hair-comb.	

A comb was formerly used to drive up the woof-thread to compact the fabric in weaving. It remains in the modern reed. Combs are used in the same manner by the modern Hindoos.

Combs for removing the grain from the straw (wheat or flax) were used in Egypt and in Rome. See RIPPLE.

2. A rake-shaped implement consisting of a head with two or three rows of tapering steel teeth, the rows being of different lengths.

The tool is used in *combing* long-stapled wool for worsted goods. The combs are used in pairs. Short-stapled wool is *carded.*

The combs or cards for wool-carding are shown in the illuminated manuscripts and missals of the Middle Ages, so called. (See Fig. 1395.) A pair of cards were as necessary an article of furniture in a house as a distaff. It is more truly a pair of *combs* than of *cards,* and the wool is evidently long-stapled. This would be indicated by the pot of hot water in which the combs are placed.

3. The serrated doffing-knife which removes the fleece from the doffing-cylinder of a carding-machine.

Fig. 1395.

A Lady carding Wool.

4. (*Hat-making.*) The former on which a *fleece* of fiber is taken up and hardened into a *bat.* Probably from *cone,* the usual shape.

5. A steel tool with teeth corresponding to those of a screw, and used for chasing screws on work which is rotated in a lathe. See CHASER.

6. The projection on the top of the hammer of a gun-lock.

7. The notched scale of a wire-micrometer.

Comb-broach. The tooth of a wool-comb.

Comb-brush. A brush to clean combs.

Comb-cut'ter's Saw. This is usually a double saw, in which two blades are affixed to one stock, one projecting beyond the other, and the less salient acting as a spacer to start the next kerf.

Another comb-cutter's saw has an adjustable slip, which acts as a gage for depth of kerf. See COMB-SAW.

Comb'er. (*Nautical.*) A ledge around the well or passenger portion of a sail-boat to keep back spray and waves which "comb" over the deck.

Comb-frame. A four-square removable frame like a slate-frame, placed in a hive to be filled with honeycomb.

Com'bi-na'tion-at-tach'ment. (*Sewing-machine.*) A device to be attached to the sewing-machine proper, and by which two or more distinct classes of work may be performed, such as *marking, folding,* and *creasing* a tuck; a *guide, hemmer, corder,* and *quilter.* See "Sewing-Machine Attachments," published by George W. Gregory, Washington, D. C.

Com'bi-na'tion-fuse. A fuse combining the principles of time and percussion, so that if the time-fuse fails to explode the shell after the proper interval, the percussion device will produce this effect when the shell strikes.

Comb'ing. An operation in the worsted, or long-wool manufacture. The operation of straightening and disentangling wool; corresponding in purpose with *carding* of short wool.

In hand-combing, the work is done between two combs, one held stationary and the other drawn over it, to comb out the lock of wool placed between them. The combs have a number of steel spikes fixed into a back, and are occasionally heated in a *comb-pot.* The short fibers which are combed out are called *noyls.* See Fig. 1395.

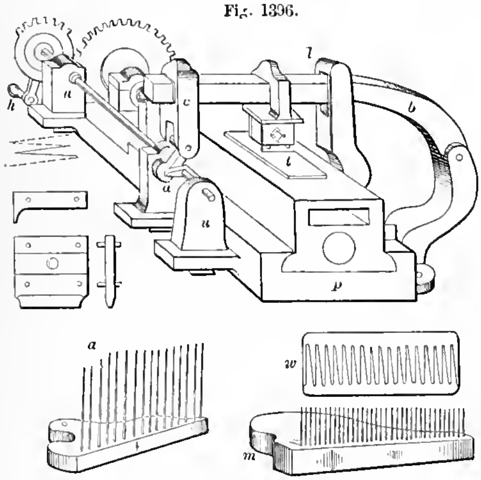
In *machine-combing,* the locks are fastened to two toothed cylinders which revolve in apposition to each other, and are heated by steam within. The teeth of one cylinder comb the fibers on the other one.

Comb-ma-chine'. Bundy's English patent, October, 1797, is the first comb-making machine on record. It consisted of a number of circular saws on a mandrel. The comb-blank is mounted on a carriage and advanced by a screw.

A mode of making combs with economy of material was invented by Ricketts, London, some years since, and has become common. A slip, a little wider than a comb, is placed in a machine which has a descending cutter of peculiar conformation adapted to cut through the tortoise-shell or horn by a series of tapering cuts which form the outlines of the teeth of a pair of combs, as in the figure (*w*), the teeth of one comb occupying the interdental spaces of the other.

Kelly's "Machine for making Parted Combs" has a bed-plate *p* which is secured by screws to a bench; from the bed-plate rise standards *u* which support an axle *a* turned by a winch *h*. On the axle is a crank which communicates motion by the collar *c* to

Fig. 1396.



Comb-Making Machine.

the arm *b*, to whose lower side the cutter is attached. As the bar works up and down in the guide *l*, the cutter makes its incisions in the tortoise-shell *t*, which is intermittingly moved so as to be advanced one notch between each descent of the cutter.

The cutter consists of two sharp blades of steel, diverging from each other so as to give the required taper to the tooth. Each blow cuts one tooth, and by severance leaves a tooth on the twin comb, the respective combs being *parted* by a slight pull when the cuts are all made.

In the sliding bed there is an opening into which a heated bar is put to keep the tortoise-shell warm and prevent its splitting.

The bed is advanced between each pulsation of the cutter by a feed-screw operated by a spur-wheel and a mutilated gear on the winch-shaft.

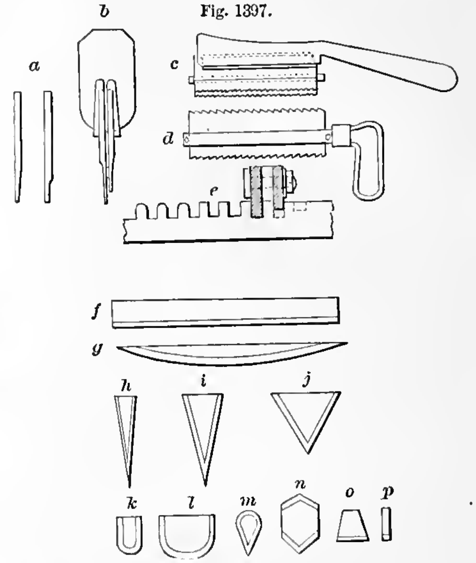
a m are brush-makers' combs. See p. 597.

Comb-pot. A stove at which the combs are warmed in the operation of preparing long-stapled wool for *worsted*.

Comb-saw. The hand-saw of the comb-cutter is called a *stadda*, and has two blades, one deeper than the other; a gage on the saw-blade determines the depth of cut. Some of the saws are serrated on each edge. The blades are made of thick steel, and are ground away on the edges as thin as the notches of the comb. They have about twenty points to the inch. Between the blades is a thin slip or tongue of metal, called a *languet*, which determines and preserves the interval. The arrangement of the two blades secures the regularity of the intervals, as the shallow tooth keeps in advance and sinks the tooth half-way, while the deeper tool completes the former kerf. The form and mode of action are shown at *a*, *b*, *c*, *d*, *e*, Fig. 1397.

The files of the comb-maker are called by specific

Fig. 1397.



Comb-Makers' Saws and Files.

names, mostly derived from the French, as are the operations. They are, —

f, the *float*; *g*, the *graille*; *h*, the *found*; *i*, the *carlet*; *j*, the *topper*.

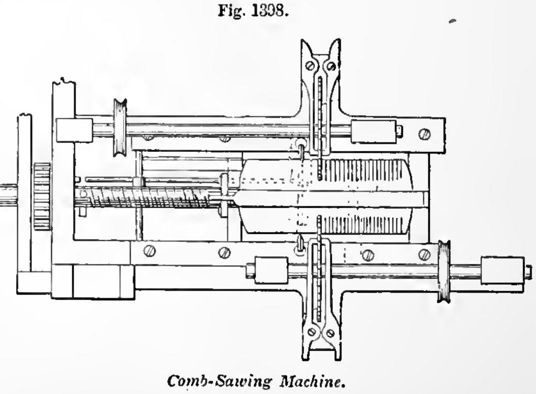
The files are of the description called *floats*; that is, they have but a single course of teeth, and incline forward at about 15°. The teeth are made by a file, as the shape is not readily obtained by chisel and hammer.

The floats *k l m n* are used by ivory-carvers for the handles of knives and in the preparation of works which are completed by scorpers and gravers.

o and *p* are used as inlaying tools.

In the comb-sawing machine (Fig. 1398) the carrier, with the stock from which the comb is produced, receives a succession of movements, each advancing the comb the distance of a tooth's width. The saws enter and recede in unison with these movements,

Fig. 1398.



Comb-Sawing Machine.

and the pointers cut nicks as starting-points for the saws, which act subsequently.

Com'et-seek'er. A cheap equatorial, with coarsely divided circles, and a large field in comparison to its aperture. Its name suggests its use, and the resultant "find" is subjected to the more accurately graduated and more powerful instruments of comparatively limited fields.

The *comet-seeker* of the Washington Observatory was made by Merz and Mahler, of Munich. It has an object-glass of about 4 inches in diameter and a focal length of 32 inches. Low powers are used, that it may embrace a large field and collect the greatest possible quantity of light. It cost $ 280.

Com-mand'er. 1. (*Nautical.*) A large wooden mallet, used in the sail and rigging lofts in driving the splicing-fid.

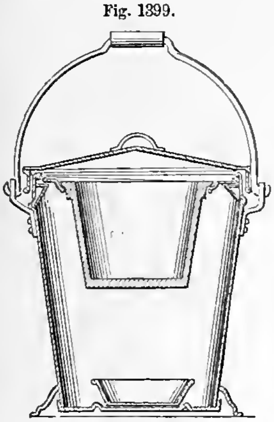
2. (*Hat-making.*) A string on the outside of the conical hat-body, pressed upon it down the sides of the block, to bring the body to the cylindrical form.

Com-menc'ing-ham'mer. The hammer of the gold-beater which he first uses after the *quartiers* are placed in a packet with interleaves of vellum. It weighs 6 or 7 pounds, and has a slightly convex face 4 inches in diameter.

Com'mis-sure. (*Masonry.*) The joint between two courses.

Com-mode'. A night closet containing a chamber vessel or urinal, with a lid and means for preventing exhalations of fetid odors. The commode has usually a seat, lid, and stench-tight joint. In the illustration, the covered pail has a pan for feces, and one for a disinfectant which deodorizes the mephitic vapors. See EARTH-CLOSET.

Fig. 1399.



Commode.

Com'mon Raf'ters. The upper rafters, holding the covering; in contradistinction to the *principal* rafters.

Com-mu'ni-ca'tion-valve. (*Steam.*) The valve in the steam-pipe leading from the boiler to the cylinder of a steam-engine.

Com'mu-ta'tor. (*Telegraphy.*) An instrument which periodically interrupts an electric current.

The word is generally used as a synonyme of *Rheotrope.*

Sometimes used (in England especially) as a name for a device for throwing into a circuit a greater or less amount of the force of a battery.

Occasionally used to designate a device for directing a current into several circuits in succession; the current being through only one circuit at a time.

It seems to be used in the above senses by various standard electricians, but they all agree in one point in their use of it; i. e. that there is *change*, either of direction, strength, or circuit of the current.

Com-pan'ion. A wooden covering over the staircase to a ship's cabin. A *companion-hatch.* The staircase is the *companion-ladder* or *companion-way.*

Com-par'a-teur. A Prussian instrument for accurately acertaining the length of measures after Bessel's mode. The micrometers are placed on a strong mahogany beam; and the slide, which carries the two measures to be compared, is so arranged that it moves them exactly behind one another in the micrometer line, and there retains them.

Com'pass. 1. A circumscribing instrument, or one for describing arcs or measurer's lines.

2. An instrument for determining horizontal direction by reference to a poised magnetized needle. See —

Amplitude-compass.	Fluid-compass.
Azimuth-compass.	Hair-dividers.
Beam-compass.	Hanging-compass.
Bisecting-dividers.	Lengthening-bar.
Bow-compass.	Magnetometer.
Bow-pen.	Mariner's compass.
Bow-pencil.	Millwright's compass.
Bullet-compass.	Musical compass.
Calipers.	Napier's compass.
Circumferentor.	Oval compass.
Circumventor.	Pencil-compass.
Club-compass.	Pillar-compass.
Compass-board.	Plain compass.
Compass-brick.	Planchet.
Compass-card.	Proportional compass.
Compass-joint.	Quadrant-compass.
Compass-needle.	Rack-compass.
Compass-plane.	Scribing-compass.
Compass-roof.	Self-registering compass.
Compass-saw.	Surveyor's compass.
Compass-timber.	Tell-tale compass.
Compass-window.	Transit.
Cone-compass.	Triangular compass.
Cutting-compass.	Tube-compass.
Diamond-cutter's compass.	Universal compass.
Dipping-needle.	Variation compass.
Dividers.	Volute compass.
Double compass.	Whole-and-half compass.
Drawing-compass.	Wing-compass.

Com'pass-bar. A fixed iron ring in the *silver-from-lead-extracting furnace,* which supports the *test* or *cupel-hearth* in place in the reverberatory, where the process is carried on. See SILVER-FROM-LEAD-EXTRACTING FURNACE.

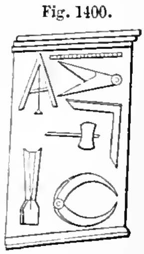
Com'pass-board. The *hole-board* of the loom for fancy weaving. It is an upright board of the loom through which pass the neck-twines.

Com'pass-brick. A brick with a curved face, suitable for wells and other circular work.

Com'pass-card. The card of a mariner's compass on which the points are drawn. It is usually attached to the needle, and is read with reference to a mark which represents the ship's head.

Com'pass-es. A two-legged instrument for measuring distances, or for describing arcs or circles.

Fig. 1400.



Roman Tools.

The compass was a common implement among the carpenters and masons of ancient times. The nonsense about its invention by Perdix, the nephew of Dædalus, and the consequent hurling from the temple of Athena by his envious uncle, is rather absurd, considering the condition of austral and oriental architecture for several thousand years then past. Nepoticide was common enough, however.

The cut is from a Roman tomb, and shows the compass, calipers, plumb, rule, square, mallet and chisel.

That the compass was known to the Egyptians cannot be doubted. It cannot be necessary to cite particular instances of its evident use in architecture and drawing. The tombs of Beni Hassan, about 1706 B. C., and Thebes, about 1500 B. C., are full of illustrations, both in their own construction and their mural ornaments, of the uses of the compass. While the dates of the Egyptian monuments have not been ascertained beyond 2100 B. C., or thereabouts, all will admit that the monuments of Osymandyas were made by a nation that had been in process of development for many centuries. So the compass was in use in Egypt many hundred years before Cecrops and his brother Egyptians left their native country and gave the first taste of arts to ancient Attica.

Several compasses were discovered at Herculaneum (overwhelmed, A. D. 79), and among the number was a pair of reducing-compasses. See BOW-PEN; DIVIDERS; also list under COMPASS.

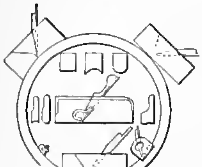
Com'pass-joint. A form of joint usual in compasses in which one leg has a circular disk or two, clamped between other disks belonging to the fellow leg.

Com'pass-nee'dle. The polarized bar which is suspended so as to assume a direction resulting from the earth's magnetism. There are several ways of suspending the needle. See MARINER'S COMPASS; DIP-COMPASS; MAGNETOMETER.

Com'pass of the Fig'ure 8. A double calipers, measuring with one pair of branches and giving the measure with the other. See CALIPERS.

Com'pass-plane. A plane with a curved face, used to work on concave surfaces. The illustration shows several forms, and also some *hollows and rounds* also compass-shaped. An ordinary smoothing-plane is also shown, whose sole is non-conformable to the surface under treatment.

Fig. 1401.

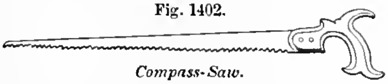


Compass-Planes.

Com'pass-roof. A bent rafter or curb roof.

Com'pass-saw. A saw with a narrow blade, adapted to run in a circle of moderate radius. By a rotation of the hand it is constantly swerved, and its *kerf* allows it some play, so that it cuts in a curve. It is usually thick enough on the cutting-edge to run without any *set*. The blade is an inch wide next to the handle, tapers to one quarter inch at the point, and has five teeth to the inch. Otherwise known as a FRET-SAW; LOCK-SAW; KEY-HOLE SAW.

Fig. 1402.



Compass-Saw.

Com'pass-tim'ber. Naturally crooked, curved, or arched timber for ships' frames, to secure deck-beams to the frames, etc.

Com'pass-win'dow. (*Carpentry.*) A circular, bay, or oriel window.

Com'pen-sa'tion Bal'ance. A balance-wheel for a watch or chronometer, so constructed as to make isochronal beats, notwithstanding changes of temperature.

It was invented by Harrison, of Foulby, England, who devoted himself for a long series of years — 1728-1761 — to the discovery of a mode of overcoming the change of rate due to the expansion and contraction of the balance.

The *compensation pendulum* requires but one adjustment, to maintain the center of gravity at an equal distance at all times, from the axis of oscillation. The *compensation balance* is subject to two variations, — one owing to the expansion and contraction, by variations of heat, of the balance itself, causing it to go slower or faster as the case may be; the other owing to the expansion and contraction of the *balance spring*, which is rendered more rigid by cold and less rigid when expanded by heat, thus exerting a variable effect under variations of temperature.

Harrison was the inventor of the *gridiron* compensation pendulum for clocks, which depends for its action upon the unequal expansion and contraction of different metals by given degrees of heat. In the search of a mode of giving an even rate to the balance-wheel of a watch, he first applied his combined steel and brass to the *curb* of the regulator, so that the spring became lengthened or shortened in a degree sufficient to compensate for its own change of tension, and also for the changed diameter of the balance.

The *curb* of the regulator has two pins which embrace the *hair-spring* or *recoil-spring* of the balance, and determine the length of the spring involved in the action. When a longer portion is allowed to play, the beat is slower, and conversely.

The English government in 1714 offered a reward of £20,000 for the discovery of a correct mode of ascertaining the longitude at sea. Harrison made four time-pieces within the years above cited, and in 1764 and following years received £24,000 for his improvements. (See CHRONOMETER.) The special point of novelty was the compensation balance, which was constructed to run at an equal rate under changes of temperature. It is formed of two metals, in the following manner: — (For illustration, see CHRONOMETER.)

A ring of steel is made with a bar across the middle; outside this ring is a ring of brass, firmly brazed to it; both rings are cut through at points diagonally opposite each other on opposite sides of the cross-bar, and a few screws with heavy heads are set in various places near the end of each portion of the cut ring; consequently, as the elasticity of the chronometer spring is diminished, and the size of the balance itself is increased, by an increase of temperature, the outer brass ring of the balance is expanded more than the inner, steel one, bending the ends of the two combined rings, with their attached screws, inward, toward the center of gravity of the balance, and causing it to make an equal number of pulsations with a lesser force; the object being to so compensate the decreased force of the spring by the decreased inertia of the balance, that the number of its vibrations shall be equal under all variations of temperature; the balance compensating for its own contraction and expansion, and for inequalities in the effectiveness of the balance-spring. The peripheral contraction or expansion under increment or decrement of temperature, respectively, is due to the unequal expansion or contraction of the metals, steel and brass, under changes of temperature; the same differential expansion or contraction that would cause them, if brazed together so as to be straight at a given temperature, to bend in one direction or the other when exposed to an atmosphere above or below that temperature.

The proper adjustment of the screws is a matter of great importance, requiring much nicety; it being necessary to make repeated trials at different temperatures, and can therefore only be done in winter or by means of freezing mixtures; thus rendering this compensation a tedious as well as expensive operation. The ultimate tests and rating are usually performed at government observatories.

Com'pen-sa'tion Pend'u-lum. A pendulum so arranged as to preserve the center of gravity of the *bob* at a constant distance from the axis of suspension, notwithstanding changes of temperature.

The principal compensating pendulums are, —

The gridiron, by Harrison.

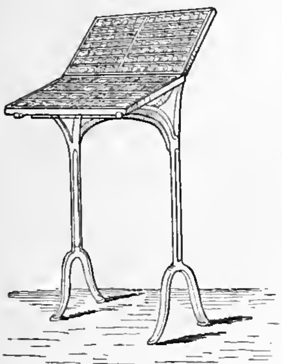
The mercurial, by Graham. See PENDULUM.

Com'pen-sa'tor. 1. (*Nautical.*) An iron plate placed near the compass on board iron vessels, to neutralize the effect of the local attraction upon the needle.

2. (*Gas.*) A device to equalize the action of the exhauster which withdraws the gas from the retorts. Should the exhauster be driven so fast as to reduce the pressure on the retorts below the desired point, the diminished pressure will act upon the elastic plate and cause the motion of a valve which allows the gas to pass back towards the retorts. The compensating device is similar to that of a gas-regulator, but the application is special for the purpose stated.

Com'po. A concrete or mortar.

Fig. 1403.



Composing-Frame.

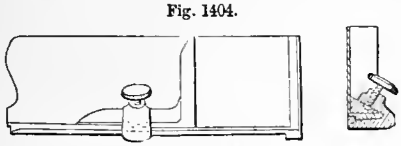
Com-pos'ing-frame. The stand on which the printer's cases rest.

Com-pos'ing-ma-chine'. A machine in which type are set up. See TYPE-SETTING MACHINE.

Com-pos'ing-stand. A frame holding the printer's cases. (Fig. 1403.) See CASE.

Com-pos'ing-stick. A metallic frame to contain type, with one open side and one adjustable end, which is moved out or in to adapt it to the width of a column. In it the type are composed

Fig. 1404.



Composing-Stick.

and justified, and from it they are transferred to the ga ley.

Com-pos'ite. (*Shipbuilding.*) A vessel having a wooden skin on an iron frame-work. Jordan's system, English patent, 1849, is as follows : —

The whole outer skin, including keel, stern, stern-post, and planking, is of wood, arranged as in the skin of an ordinary wooden ship ; and the frame-work inside the skin, including frames, beams, keelson, stringers, shelf-pieces, water-ways, hooks, transoms, diagonal braces, etc., is of iron, arranged nearly as in an ordinary iron ship. Tables of rules for sizes of the different parts are given in the appendix to the third division of the folio work on "Shipbuilding," by Messrs. Watt, Rankin, Barnes, and Napier. Mackenzie, London, 1866.

Certain variations are found in composite building.

Bettely introduced trough-shaped or "channel iron" for the frames.

MacLaine's system consists of an inner skin of iron and outer skin of wood, on an ordinary iron frame.

Heni's system : an inner skin of iron to which are riveted transverse iron frames of a Z-shaped section. The angles of these frames are filled up solid with wood, and an outer wooden skin covers the whole.

Captain Skinner's system : an iron frame imbedded between two wooden skins.

Feather's system : wooden bottom and iron top-sides. The iron frames terminate at their lower ends in broad forks or saddles, which sit upon and are fastened to the wooden parts of the sides.

Com-pos'i-tor. See TYPE-SETTING MACHINE.

Com'pound Arch. An arch which has the archivolt molded or formed into a series of square recesses and angles, and practically consisting of a number of concentric archways successively placed within and behind each other.

Com'pound ax'le. One consisting of two parts joined by a sleeve or other locking device. See AXLE.

Com'pound Bat'ter-y. A Voltaic battery, consisting of several pairs of plates, developing a cumulative effect. See GALVANIC BATTERY.

Com'pound Mi'cro-scope. A microscope made up of a combination of lenses arranged in a tube. See MICROSCOPE.

Com'pound Pier. A clustered column.

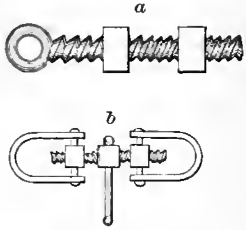
Com'pound Rail. A rail made of several portions with a longitudinal joint, avoiding the transverse joint across the rail whereby the jarring is occasioned. A *continuous rail.*

The term may also be applied to several forms of rails which consist of a number of portions bolted or keyed together.

Com'pound Rest. (*Lathe.*) The tool-carrier of an engine-lathe, moved longitudinally (along the work) by the *leading-screw*, actuated by the feed ; and transversely (to or from the work), by its own feed-screw.

Com'pound Screw. Two or more screws on the same axis. When the pitch of the respective screws varies, it forms a differential screw (*a*) ; when they run in different directions, it is a right and left screw (*b*).

Fig. 1405.



Compound Screws.

Com'pound Steam-en'gine. (*Steam.*) A form of steam-engine originally patented by Hornblower in 1781, in which steam at a relatively greater pressure was allowed to expand in a small cylinder, and then, escaping into a larger cylinder, to expand itself against a larger piston. As steam was applied in his day at so very small a pressure, the particular value of the idea was not developed until Trevethick and Woolf used a high pressure in the first cylinder with expansion into a larger one.

Trevethick applied high-pressure steam to Watt's ordinary single cylinder or Cornish engine, while Woolf revived and modified Hornblower's engine, and, by working it with high-pressure steam, obtained results far beyond those of the original inventor. Woolf's first engine was erected at Meux's brewery in 1806. He took up his residence in Cornwall about 1813, where he astonished the Cornish engineers with the results obtained, but ultimately they found that high-pressure steam, applied to the single-cylinder engines, produced equally good results at the ordinary pressures when used expansively.

Compound engines are of two classes, which may be called combined and independent compound engines. The former are those in which the cylinders are near each other, and the pistons commence their respective strokes simultaneously or nearly so, the steam expanding from one cylinder direct to the other through as small a passage as convenient. To this class belong most land engines, and the compound marine with cranks at about 130°. In independent compound engines, the cylinders need not be near, and the pistons need not — generally do not — make their strokes together; their distinctive feature being that the steam passes from one cylinder to a receptacle which may be as large as convenient, and that from this the large cylinder takes its steam. To this class belong many condensing land engines, furnished with auxiliary high-pressure cylinders, and the compound marine engines with cranks at right angles. See DOUBLE-CYLINDER STEAM-ENGINE; DUPLEX STEAM-ENGINE.

Com′press. 1. A pledget of tow, folded linen, or lint, to press upon any part to stop bleeding, arrest circulation, or for other purpose.

2. A machine for re-pressing cotton bales.

Com-pressed′-air En′gine. One driven by the elastic force of compressed air. Its construction is usually like that of a steam-engine, the force of the expanding air being exerted against a piston in a cylinder.

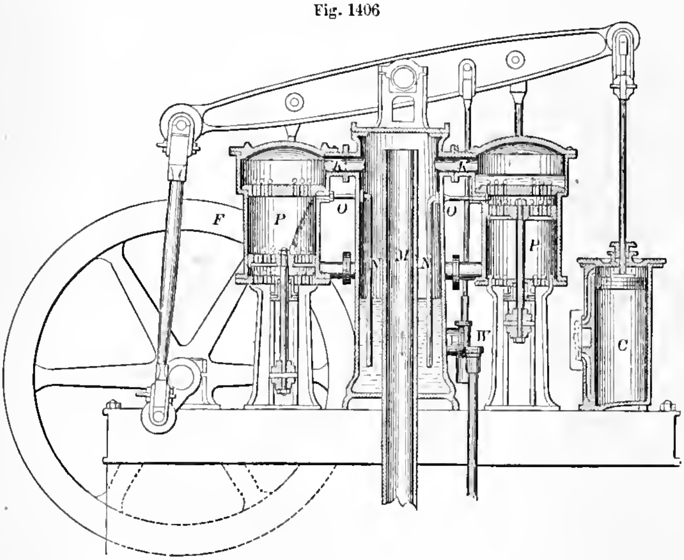
An air-compressing machine for the service of such an engine was built, previously to 1856, by Randolph, Eliot, & Co., of Glasgow, Scotland, for Govan Colliery, near that city, and was described in the proceedings of the Institution of Mechanical Engineers at Glasgow. It was used to condense air to work an ordinary high-pressure engine at the lower shaft of the mine. It was held by those who were familiar with the construction and working of the engines, that a more valuable effect would have resulted from working the air expansively, cutting off at one third stroke and expanding down to the atmospheric pressure. A valuable feature developed in this connection was the low temperature of the escaping and expanding air, which was very salubrious in a mine whose temperature varied from 80° to 90° F. The apparatus had been in use six years without requiring any repair beyond the replacement of some of the valve-cages.

The air-main was of the area of the working cylinder, and the difference in pressure at the two engines was only one pound in favor of the upper one.

Fig. 1406 is a vertical section of the compressing engine, in which the steam-cylinder *C* is 15 inches in diameter, with a stroke of 3 feet; it drives two condensing air-pumps *P P* which work alternately, one on each side of the beam center, delivering the air into the center reservoir *N N*, from which it passes into the main pipe *M*. The beam is connected at the other end to a crank and fly-wheel *F*, for the purpose of equalizing the motion.

The air-pumps *P P* are 21 inches in diameter, with a stroke of 18 inches; they are placed inverted, with the piston-rods passing out below, where the stuffing-boxes are not exposed to the pressure of the compressed air, and are worked with cross-heads, sliding in vertical guides by means of side rods from the beam. The air-pumps are fitted with ball-valves, of which there are three sets to each pump, each set consisting of 44 brass balls, 2 inches in diameter, arranged in three concentric rings. The balls are confined by separate cages to a lift of ½ inch. A stratum of water supplied by a pump *W* covers the piston valves, and the delivery and inlet valves, through which all the air has to pass. The water flows from the central reservoir through the small pipes *O O* into each of the air-pumps during the periods of their downward strokes. The surplus water is discharged at each upward stroke through the delivery valves, keeping them also covered with water.

Fig. 1406



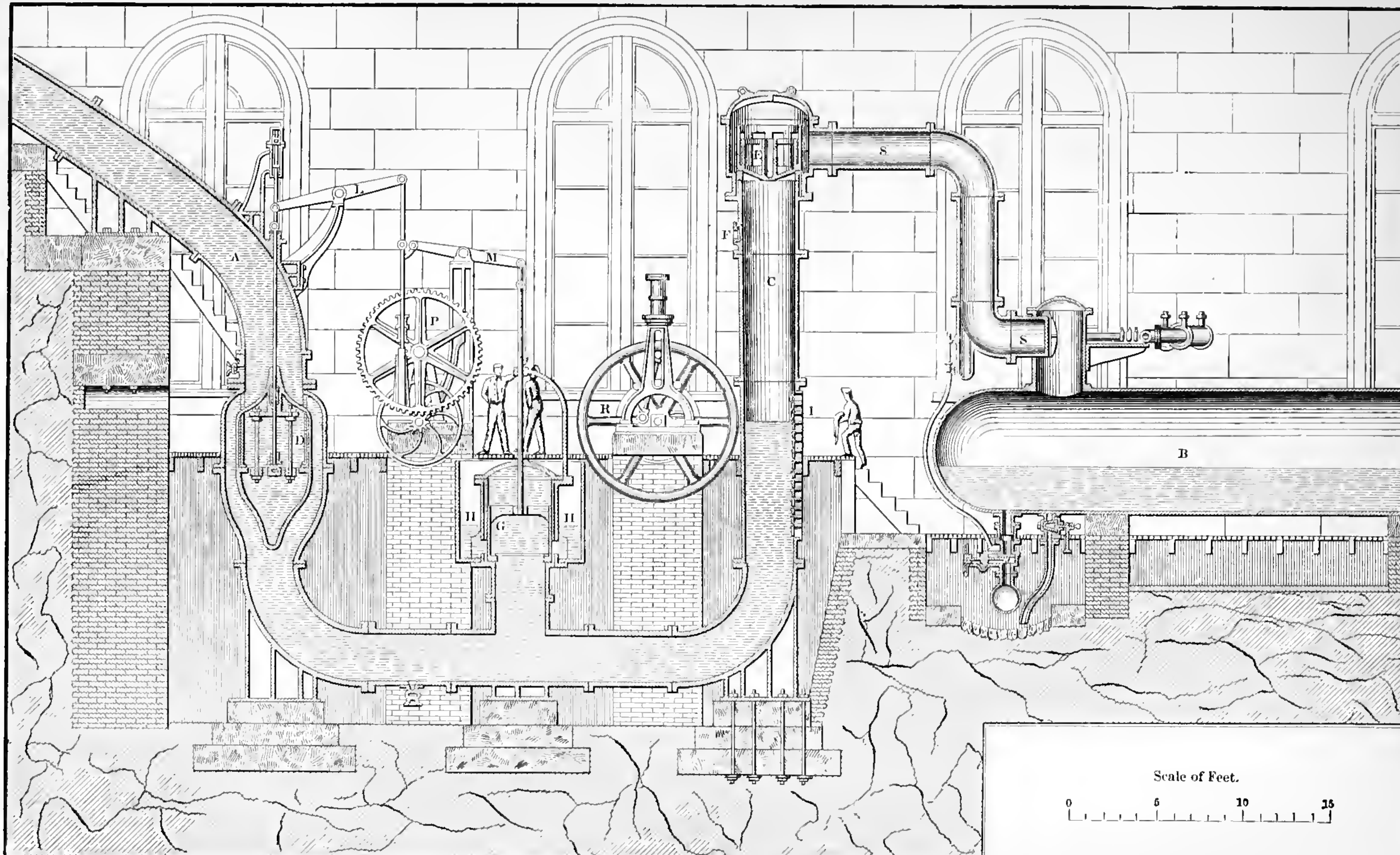
Compressed-Air Engine.

The compressed-air engine at Ardsley Colliery, England, travels upon wheels and is pushed to its work by hand. A steam-engine at the surface compresses air to a pressure of from 50 to 60 pounds to the square inch, and the air is conveyed by metallic tubes to the bottom of the mine, and by a caoutchouc tube to the engine. It undercuts 3 feet deep and 150 feet long in 8 hours.

One of the Mount Cenis Tunnel air-compressors, invented and constructed by Sommeilleur, and placed at Bardonneche, the Italian end of the tunnel, is represented by a vertical longitudinal section on the page opposite. The description is condensed from the report of Dr. F. A. P. Barnard, United States Commissioner to the Paris Exposition.

The compressors operate by applying the living force of a large column of water descending in an inclined tube *A*, to drive a body of confined air into a receiver *B*, within which there is maintained a constant pressure of six atmospheres by means of an hydraulic head. Each compressing-engine is an inverted siphon, having the long arm *A* inclined and the short arm *C* vertical. The puppet-valve *D* is for the purpose of regulating the periods of motion and rest of the contained water column.

The short arm *C* of the siphon is the chamber into which is introduced the air to be compressed. At its upper extremity it communicates by a valve *E* with the receiver *B* of compressed air. This valve is kept closed by the pressure of the air in the receiver, so long as the pressure beneath it is less, but when the air beneath attains by compression the same tension as that already in the receiver, the valve opens and the new charge enters.



SOMMEILLEUR'S AIR-COMPRESSOR.

PLATE X

BARDONNECHE, MT. CENIS TUNNEL.

See page 602.

The compression-chamber *C* receives its successive charges of air from the atmosphere by valves *F* opening inward. It is freed from water after each pulsation or act of compression, by means of another valve *G*, which opens at a level somewhat above the bend of the siphon, so that the bend itself and the long arm remain always full of water, the overflow at *F* being discharged through the canal *H*.

The action of the machine is as follows: — The air-chamber *C* being full of air at the ordinary density of the atmosphere, the great valve *D* in the inclined pipe *A* is opened, and the water rushes through the short bend into the chamber *C*, compressing the air before it, and finally driving it through pipe *S* into the receiver *B*. The water then comes to rest, the supply valve *D* closes, the discharge valve *G* opens, the water escapes at *H*, and a new charge of air enters at *F*.

L is the motive lever of the feed-valve, *M* the motive lever of the discharging-valve. *P* is the gearing by which the proper correspondence of motion between the respective valves is secured. *R* is the engine which operates the gearing *P*, and intermediately the valves *D G*.

The difference of level between the head of the driving column of water and the point of discharge is 85.25 feet. The diameter of the tube is 23.56 inches, and the hight of the air-chamber, measured from the level of discharge at bottom to the valve opening into the recipient at top, is 47.12 inches. These measurements would give for the total capacity of the air-chamber 39.9 cubic feet; and this is the maximum charge which the machine is capable of compressing at a single impulse. The charge actually compressed, however, is less than this, and is determined by the condition that the resistance which it opposes to the driving force, during its compression and subsequent passage into the recipient, shall exhaust this force exactly, without excess or deficiency. In case the resistance is in excess, a portion of the air will fail to pass into the receiver and so be lost. In case it is in deficiency, a portion of the motive-power will be uselessly expended, and, moreover, the column of water will strike the top of the air-chamber with violence, and may damage the machine. The practical adjustment of the bulk of the charge to the power of the engine is attained by a tentative process, a series of small valves *I* being adapted to the side of the air-chamber in a vertical row, through which the air can escape, but which the air by its inertia closes successively as it rises. If, in a series of experiments, these valves be secured one after another, beginning at the top, the charge of air will be gradually increased, until at length it is found to have the volume required.

There were at Bardonneche ten of these compressors constantly at work, each one making three impulses per minute, or 4,320 per day. If the charge at each impulse were equal to the capacity of the air-chamber, the total volume of air compressed daily would be 1,723,204 cubic feet. It appears that the volume actually compressed amounted to only 826,020 cubic feet, so that the charge in the compressor was but about 19 cubic feet at each impulse.

The power of such a compression machine is equivalent to that which would be generated by the descent of a vertical column of water 85.25 feet in length and 23.56 inches in diameter through a space of 47.12 inches three times per minute through the day. The calculation shows that this would a little exceed 18-horse power. The whole ten of the compressors furnished, accordingly, 180-horse power.

The power employed is actually capable of compressing 1,195,258 cubic feet daily, to a bulk under the pressure of six atmospheres of 305,350 cubic feet, becoming by subsequent contraction 201,210 cubic feet. But the amount actually compressed was only 826,020 cubic feet daily, giving ultimately 137,670 cubic feet of compressed air at the normal temperature. This represents a compressing force of only 125-horse power, being less by 55 than the theoretic force of the compressors.

The 137,670 cubic feet at the pressure of six atmospheres are capable of producing an amount of work hardly equivalent to 75-horse power. There was therefore a loss at Bardonneche, from causes known and unknown, equal to seven twelfths of the hydraulic force employed.

The same hydraulic power, or an equivalent steam power, would probably be applied more effectually in compressing air by means of pumps, than in the method above described. This the engineers themselves appear to have tacitly admitted, by introducing pumps at the northern entrance of the tunnel.

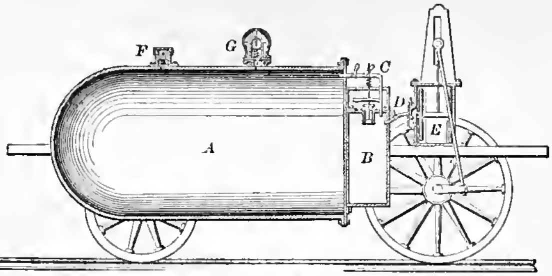
The success of the Mont Cenis tunnel and the progress of the Hoosac have settled the question of the availability and economy of the system of transmission of compressed air by pipes. The cooling and ventilation, as has been already remarked, are important auxiliaries. The Hoosac Mountain is being daily pierced at either end about five feet, by means of rock drills, using compressed air as a motor. The practice at Mont Cenis carried air at 50, 60, and 70 pounds to the square inch 4 miles in pipes of 8 and 10 inches diameter, and at Hoosac tunnel, Massachusetts, air was carried at 60 and 65 pounds to the square inch 1⅞ miles with little or no loss. There are other instances of long conducts, in pipes from 1 inch to 8, 9, and 10 inches. Near Mauch Chunk, Pennsylvania, a railroad tunnel is being driven, or has been completed, under a mountain by the same agency.

The piers for Roebling's East River Bridge, and those for Eads's Illinois and St. Louis, are sunk by the aid of compressed air conveyed in tubes.

Locomotives have been driven by means of air compressed into reservoirs, and are briefly referred to in the article on AIR-ENGINE. One of these was invented by BOMPAS (English patent, 1828). On the frame of the locomotive were two tanks which were charged with compressed air by stationary engines at the depots and way-stations. The air operation was substantially similar to that of a steam-engine, the air being admitted from alternate reservoirs to the sides of the pistons with which the said reservoirs respectively communicate. The piston-rod is connected in the usual manner with the crank and driving-shaft. An engine, similar in most material respects to the above, was made by Baron von Rathlen, in 1848, and was driven by its air motor from Putney to Wandsworth (England), at the rate of ten or twelve miles per hour.

PARSEY, in 1847, invented an engine of this character in which a large reservoir *A* was secured to a frame mounted on wheels. In this reservoir the air was compressed to as great an extent as was compatible with safety, and was emitted gradually into the chamber *B*, where it expanded to its working pressure. This emission is regulated automatically by a plunger in a tube passing through the roof of the chamber *B*. Above the plunger is a spring which yields to the normal or working pressure of the air in the chamber *B*; but when, owing to the withdrawal of air to the working cylinder, the pressure in the chamber is relaxed, the spring depresses the plunger

Fig. 1407.



Parsey's Compressed-Air Engine.

and the connections of the latter turn a faucet-valve in the pipe *C*, and allow the passage of air from the reservoir *A* to the chamber *B*, to restore the working pressure in the latter. The compressed air passes by the pipe *D* to the cylinder *E*, where it acts in the manner usual with the double-acting steam-engine, and exhausts into the atmosphere. *F* is the supply aperture through which the reservoir is charged, and *G* the safety-valve. The piston-rod, cross-head, and pitman connect in the usual way with the crank and driving-shaft.

The project has lately been revived for impelling street-cars.

Under "Air as a Means of Transmitting Power," has been noticed the attempt of Dr. Papin of Blois to run a pumping-engine by compressed air conducted by pipes from a condensing engine situated at the distance of a mile and driven by a fall of water. For some reason, friction and leakage probably, the doctor failed.

For the application of compressed air as a water elevator, see "Air as Water Elevator, Compressed."

In the city of New York, in 1858 or 1859, Captain Ericsson arranged a power to run sewing-machines for a clothing firm in that city. A caloric engine in the cellar compressed the air; it was carried to the upper story in pipes, and there moved little engines, which, in turn, operated sewing-machines to the number of some eighty. The act of compressing air throws off its heat, and then when it is again exhausted, it takes up that heat again from the surrounding atmosphere, doing two things, condensing and precipitating the vitiated air, and furnishing one of the best possible means of ventilation. These machines worked successfully for years.

H. H. Day now proposes to transfer the power of the Niagara Falls to Buffalo, minus certain admitted losses in working, which would leave a handsome surplus. Also the lower falls at Rochester, N. Y., to that city. *Nous verrons.*

Com-press'ing-ma-chine'. A machine for making compressed bullets.

Com-pres'sion-cast'ing. A mode of casting bronzes, etc., in molds of potters' clay under a pressure which causes the metal to flow into the delicate tracery left by the pattern. The work approaches nearly the work of the graver and chisel. It is especially used in casting house-builders' hardware, letters and numbers for houses, stamps, etc.

Com-pres'sion-cock. One containing an india-rubber tube which is collapsed by the pressure of the end of a screw-plug turned by the key.

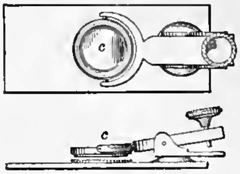
Com-press'or. 1. (*Surgical.*) An instrument to compress the femoral artery; a substitute for a tourniquet.

2. (*Nautical.*) *a.* A lever arm to press on the chain-cable and keep it from veering away too fast.

b. A device for compressing a gun-carriage to its slide or platform during recoil; the carriage is again set free for running up.

3. (*Microscopy.*) A device to flatten microscopic objects under examination,

Fig. 1408.



Lever-Compressors.

in order to make out their structure. The ring *c* and the base-piece beneath it are glazed, and, while not obstructing the light, form surfaces between which the object is flattened, or merely held. A compressorium.

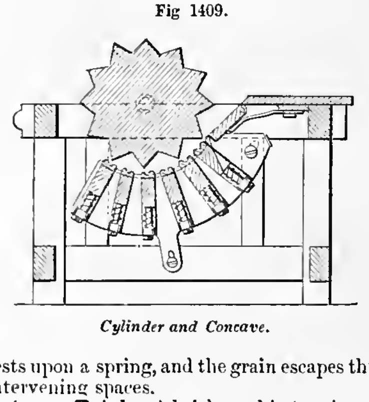
Compressors for the microscope are of various kinds; as, *lever, reversible cell, parallel plate, Wenham's*, etc.

4. (*Pneumatics.*) A machine for compressing air. See AIR-PUMP; COMPRESSED-AIR ENGINE; AIR-COMPRESSING MACHINE.

Com'rade-bat'ter-y. One of a pair of *joint batteries*.

Con'cave. The curved bed or breasting in which a cylinder works, as in the case of a thrasher. Fig. 1409, the example, shows a concave in which each

Fig 1409.



Cylinder and Concave.

slat rests upon a spring, and the grain escapes through the intervening spaces.

Con'cave Brick. A brick used in turning arches or curves. A *compass*-brick.

Con'cave Plane. A compass-plane for smoothing curved surfaces.

Con-ca'vo-con'vex File. A file with curved faces, respectively concave and convex, made by cutting a flat file and then bending it into shape between dies. The mode is the invention of Sir John Robison, President of the Scottish Society of Arts, and is designed to enable the convex side to be cut like a flat file by a chisel which reaches across the edge, instead of by cutting numerous courses, which usually cover the convex surfaces of files.

Con-ca'vo-con'vex Lens. A lens whose sides are respectively concave and convex, the latter face having a curve of the greater radius, so that the lens is thicker at the margin than elsewhere.

It differs from a *meniscus* in that the concave face of the latter has the larger radius, and the margin is an edge where the two faces run together.

Con'cen-tra'tor. An apparatus for the separation of dry, comminuted ore, according to the gravity of its particles, by exposing a falling sheet of ore-dust to intermittent puffs of air. The action has been compared to that of the jigger which acts in a water-cistern, the body of ore in the sieve being jerked up and down in the water, and thereby separated into strata of varying gravities and consequent richness. The analogy is not perfect, for in the *jigger* the ores all lie in the sieve, but the upper layer is poor and is raked off as refuse, while the succeeding layers are progressively richer down to the best at the bottom, the different grades being scraped off in succession, and either reworked or laid aside for smelting, as the case may be.

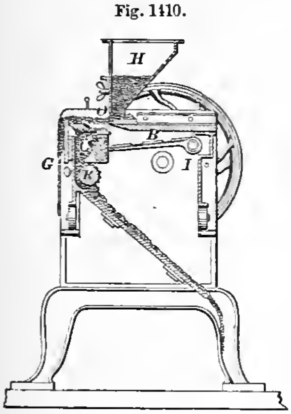
The action of Krom's concentrator is more like that of a fanning-mill, in which the richer portions (the grain) withstand the blast and fall into the receiver, while the lighter portions, which have but few metallic particles, are blown over and correspond to the tailings of the grain-winnowing machine.

A form of concentrator analogous to the smut-mills might be contrived, the ore passing through a trunk, the lighter being carried the farthest, a separation into grades of comparative gravity being thus effected.

Krom's concentrator has an arrangement in which the ore passes from a hopper on to a sieve, upon which it forms a bed. This bed of ore is intermittingly lifted by a pulsating blast beneath, so that it becomes sorted into layers of comparative gravities. The upper is the lighter portion or refuse, and falls over the end of the sieve as tailings; the heavier portion passes through the meshes of the sieve, and is collected in a receptacle beneath.

In the comparison between the *jigger* and the *concentrator*, it will be found that in the heavier medium, water, the material will sink slowly, and thus the particles will tend to sort themselves effectually. In the *concentrator*, the medium being lighter, the ore will fall more quickly. As it is necessary that the ore, between each pulsation, either in the *jigger* or in the *concentrator*, shall have time to fall again on to the sieve after each saltation, the ore in the *concentrator* may be more rapidly pulsated than it can be in the *jigger*.

Fig. 1410.



Krom's Ore-Concentrator.

Water is said to admit of from 50 to 80 lifts per minute, and air from 300 to 400 in the same space of time. Whether the more rapid action in air be more effectual than the more perfect suspension and gradual subsidence in water, is a matter to be determined by experiment and persistent trial. It is not safe to argue the question on general grounds.

The machine has a receiver *H* to hold the pulverized ore; an ore-bed *S* on which the ore is acted upon; the gates *O G* to regulate the flow of ore from the receiver and depth of ore on the ore-bed; passage *C* for the ore; and roller *R* to effect the discharge of the same; bellows *B* to give the puffs of air; a trip-wheel and spring to operate the bellows; a ratchet-wheel and pawl to operate the discharge-roller *R*.

It is operated as follows: — Ore is placed in the receiver *H*, and the driving pulley set in motion. On the opposite end of the pulley-shaft is the trip-wheel, which acts against a lever; by the joint action of the trip-wheel forcing the lever in one direction and the spring carrying it suddenly back in the opposite one, the bellows *B* is made to swing on the shaft *I*, giving at each upward movement a sudden puff of air through the ore-bed, and lifting the ore lying on it.

The spring is adapted to produce the best result, as it is important that the puff of air should be sudden. On the trip-wheel are six projections; therefore the speed of 50 to 70 revolutions per minute of the pulley gives 300 to 400 upward movements of the bellows.

Other forms of concentrators for comminuted ore, amalgam, auriferous sand, and sulphurets consist of agitated pans, reciprocated or revolving in a rotary path, and having inclined beds over which the material is sorted by gravity and discharged at different outlets.

Con-cen'tric En'gine. One name for the rotary engine (which see).

Con'cer-ti'na. An instrument with a bellows and free reeds, on the princip e of the accordion. It is grasped by both hands, and the keys are on each of the heads. An instrument of sweetness, power, and compass. Invented by Professor Wheatstone.

Con'cha. (*Architecture.*) The concave, ribless surface of a vault.

Con-chom'e-ter. An instrument for measuring shells. *Conchylcometer.*

Con-clud'ing Line. (*Nautical*). *a.* A small line hitched to the middle of the steps or stern-ladders.

b. A line leading through the middle of the steps of a Jacob's ladder.

Con-crete'. A mixture of rubber, stone chippings, gravel or broken stones, with lime and water. It is used in foundations and in filling in between masonry facings of walls. It differs from pisé material in having lime instead of clay to form a bond for the stones. See PISÉ-WORK; BÉTON.

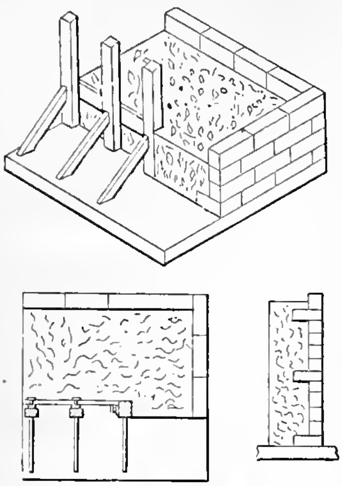
The ancients used concrete very largely. In wall building, it is usually made by dumping the materials into the trench dug for the foundation, the gravel, sand, lime, and water being thrown in, in proper quantity; or the materials are measured into a barrow, into which water is poured, and the whole dumped into the hole or trench where it is required. The proportions of sand and lime are those suitable for forming mortar. The mortar forms a bond for the larger stone, constituting a matrix of hydrated silicate of lime.

To guard against the filling up of the Saïd end of the Suez Canal by the deposits of the Nile, great blocks weighing twenty tons each, of a composite stone, formed out of hydraulic lime ground to dust by powerful mills, and mixed with sand, are sunk and piled in the harbor, and piers constructed thereon. Three hundred thousand tons of these blocks have been used at Port Saïd alone. See BÉTON.

The walls of the fortress of Ciudad Rodrigo, in Spain, are of concrete. The marks of the boards which retained the semi-fluid matter in their construction are everywhere perfectly visible; and besides sand and gravel, there are large quantities of round bowlder-stones in the walls, from 4 to 6 inches in diameter, procured from the ground around the city, where they abound.

Schroder's cement : coal-ashes, 100 ; hydraulic cement, 16 ; Portland cement, 1 part. Work in a pug-mill and mold. Cooley's : coarse pebbles, 60 ; rough sand, 25 ; lime, 15. Semple : pebbles, 80 ; rough sand, 40 ; lime, 10.

Fig. 1411.

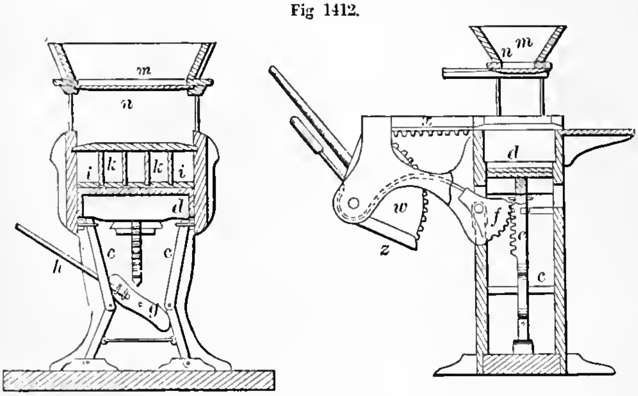


Concrete-Wall Building.

The mode of building concrete walls is indicated by the cut, in which the mass of mortar is held between facing walls of brick and inner boards, the latter being temporary.

Con-crete′-press. A machine in which a mass of concrete is pressed into the form of a building block. The concrete is placed in the hopper *m*, and, when the slide *n* and the lower slide are withdrawn, drops into the box, which has divisional partitions *k k* and a bottom *i*. The slide is replaced by the motion of the sector *w*, which moves the rack *x*. The pressure is then brought beneath the follower *d* by means of the lever *h*, cam *g*, and toggles *c c*. The lid of the press-box is then withdrawn, and the block is lifted out of the box by the sector and rack *f c*.

Fig 1412.

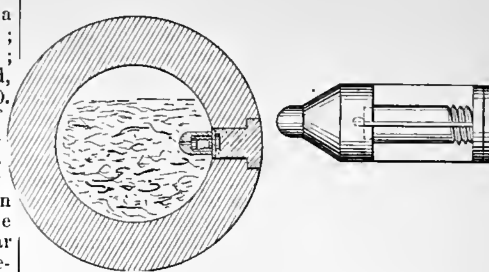


Concrete-Press.

Con-cret′er. A form of apparatus for concentrating sirup, by allowing it to flow in a boiling condition over the surface of a heated pan, and then subjecting it to the heat of a copper cylinder revolving over a fire, and having an internal hot-blast. The sirup in a concentrated condition is discharged at the lower end.

Con-cus′sion-fuse. A fuse which is ignited and explodes the shell at the moment of impact, by the breakage of a capsule or other similar internal arrangement, containing chemicals which explode by the force of the blow. The figure shows a spherical and an elongated projectile provided with a fuse which is exploded by the jar of impact.

Fig. 1413.



Concussion-Fuse.

Con-densed′-let′ter. (*Printing.*) One with a narrower face than usual with the given hight.

Con-dens′er. An apparatus for *cooling* heated vapors to a temperature at which they become liquid ; or, fumes to a temperature at which they are precipitated ; or, impure and heated gases to a more cleanly and cool condition ; or, a heated vegetable extract or juice to a less fluid condition.

Or by *pressure*, bringing a sliver or film of fiber to a slightly felted and more solid condition ; or, a foil to a more compact state ; or, an elastic fluid into a smaller bulk.

Or, by convergence concentrating the heat and light of a pencil of rays upon a relatively small area.

Or, a means of absorbing minute electrical effects.

1. (*Steam-engine.*) A means of reducing to a liquid form the steam in front of the piston so as to obtain a partial vacuum at that point, and thus utilize the natural pressure of the atmosphere.

Steam-engine condensers are of several forms : —

The injection *condenser* was invented by Watt, who was a philosophical-instrument maker in Glasgow, when, in 1764, a model of an atmospheric engine (Newcomen's), belonging to the University of Glasgow, was brought to him to repair ; the cylinder of this model was 2 inches in diameter, and 6 inches in length. Having repaired damages, whatever they were, the little machine was put to the proof, but failed to work satisfactorily.

He made a working machine on a larger scale, the cylinder being 6 inches diameter, 12-inch stroke, and was made of wood boiled in linseed-oil. Still the little machine was obdurate, and he failed to realize the results he supposed attainable.

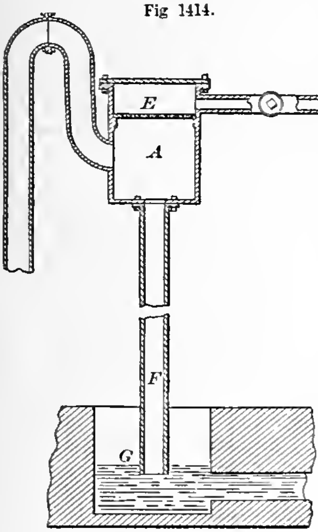
The engine working on the atmospheric principle, the valuable effect was in proportion to the perfection of the vacuum obtainable below the piston. But here a trouble met him. If he injected so large a quantity of water as to obtain a good atmospheric pressure, the cylinder was so much cooled that he lost a great quantity of steam in warming it up, and it became necessary to strike a mean. Smeaton, who had probably obtained the best results up to this time, rarely cooled the contents of the cylinder below 180°, at which temperature the steam has a pressure equal to a column of 15 inches of mercury. Thus he lost half the atmospheric pressure for the sake of avoiding the great waste of incoming steam which condensed against the sides of the cylinder until the latter acquired the heat of the steam, all which was necessary before the engine could make the up-stroke.

Watt instituted a series of very careful experiments on the relation between temperatures and pressure of steam, and brought to bear upon the subject careful analysis as well as genius. The result was the *separate condenser*. Instead of cooling the cylinder, he connected it with another vessel in which the refrigeration was accomplished, a valved communication being provided between the two.

The engine was thus the atmospheric engine with a separate condenser, securing economy of fuel and time with increase of power.

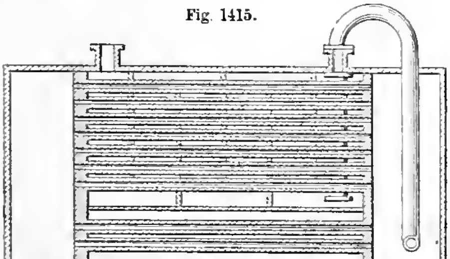
If the inventor had stopped at this point he would have found that the condensers would after a while become charged and inoperative; so he contrived a pipe 34 feet long (Fig. 1414), which led away from the condenser, its lower end being submerged in a tank, and inasmuch as such a column is greater than can be supported by the pressure of the atmosphere, the water would leave the condenser, which would then be occupied only by steam and air. The steam enters the chamber *A* by the bent pipe, and the water the chamber *E* by the other pipe, and passes in a shower through the perforations in the chamber, condensing the steam and carrying it down the discharge-pipe *F* into the cistern *G*. The pipe is so long that the weight of the column of water makes an almost perfect vacuum, and thus dispenses with an air-pump for discharging the heated water. The device is also used in vacuum-pans, etc. The pipe *F* is shown with a break and gap to indicate that a large portion is removed to bring the device within proportions convenient for display upon the page. See ASPIRATOR; AIR-PUMP (Fig. 115).

Fig 1414.



Vertical Column Condenser.

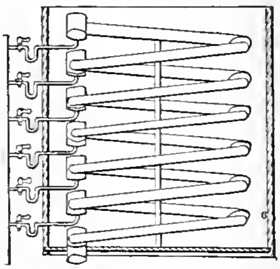
Fig. 1415.



Surface-Condenser.

The *surface*-condenser has a series of flat chambers or tubes, usually the latter, in which the steam is cooled by a body of water surrounding the tubes. The most secure way of fastening the tubes in the heads is Horatio Allen's wooden thimble, which swells after placing in position, and makes a tight joint. Distilled water for ships' use is obtained by the condensation of steam in a surface condenser. To render it more palatable it is artificially aërated and then filtered through animal charcoal.

Fig. 1416.



Worm-Condenser.

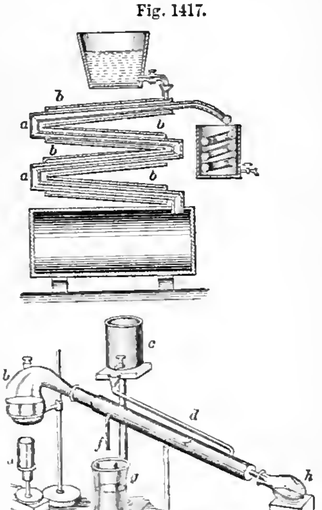
2. (*Distilling.*) The *still-condenser* is generally of the *worm-tub* form; the coil containing the alcoholic vapor traversing a tub which receives a constant accession of cold water, condensing the vapor in the coil. The liquid escapes at a cock below.

In the example, the liquor condensed in each coil may be separately withdrawn.

In Hadley's still the pipe rising from the still has successive condensers *b b* in ascending series, the liquid in the condenser jackets being gradually cooler as they recede from the still. The object is to eliminate by successive stages a liquid of given tenuity, and return the heavier condensed vapors.

In Liebig's, the neck of the still *b* passes through a water-jacket *e* to the receiver *h*. The jacket is furnished with a constant stream of water from cistern *c*, by pipe *d*, and exit *f*, to waste-cup *g*. *a* is the lamp.

Fig. 1417.



Still-Cond nser.

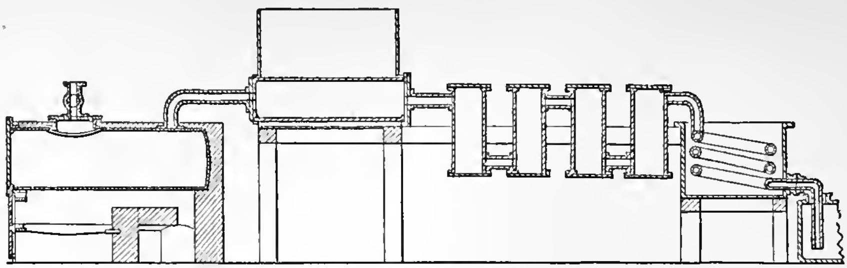
In Fig. 1418 is shown an apparatus for preparing purified ammonia, from the ammoniacal liquor of gas-works, by distillation, cooling, and treating the products with charcoal, and condensing the liquid.

Fig. 1419 is an apparatus in which a condenser *C* is placed between the vacuum-pan *A*, and the air-pump *G*, so as to condense any alcoholic spirit which may have formed in the sugar or molasses under treatment.

3. (*Metallurgy.*) An apartment in which metallic or deleterious gaseous fumes are condensed to prevent their escape into, and contamination of, the atmosphere.

These have been tried with more or less success in the copper-works of Swansea, the lead-works of England, and in various other manufactories. The

Fig 1418.

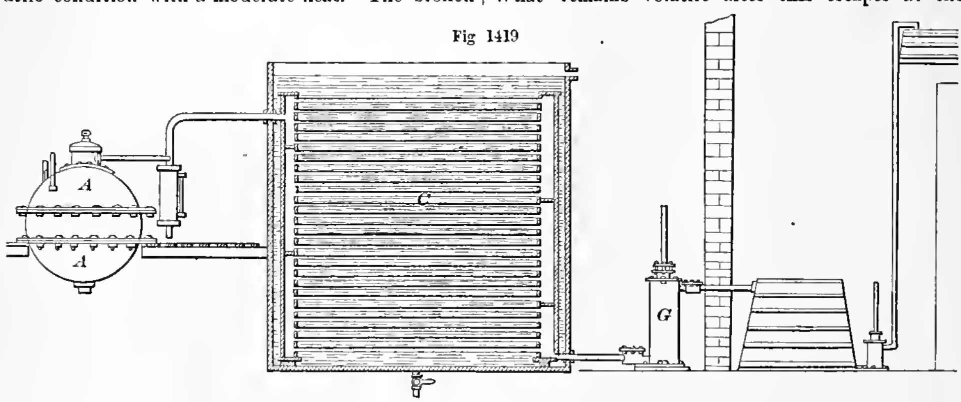


Ammonia Still and Condenser.

general feature is a prolonged duct for the fumes, with showers of water to condense the arsenical, sulphurous, and other fugitive volatile matters. The same devices serve an economical purpose in saving fugitive fumes of lead, zinc, mercury, sulphur, antimony, etc. See ARSENIC-FURNACE.

Fig. 1420 is a furnace and condenser for the dry distillation of ore of metals capable of assuming volatile condition with a moderate heat. The broken ore is fed from the hopper *C* into the revolving-drum *A*, which is heated by the furnace *B* and supplied with air under pressure by the pipe *E* from the air-pump. The heated ore is ground by the rolling balls *G*, and the fumes escape by the bent pipe *D* through the succession of sealed water-chambers *H H' H''* and pipes *D' D'' D'''* to the partitioned chamber *J* and the concluding vessel *K* which contains mercury. What remains volatile after this escapes at the

Fig 1419



Condenser for Alcoholic Vapors of Sugar.

chimney *L*. The post *M* supports one trunnion of the drum, and the other trunnion is a sleeve carrying the cog-wheel.

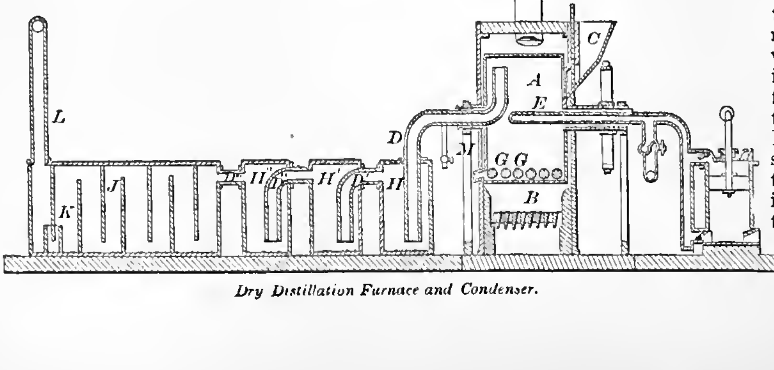
4. (*Gas-making.*) An apparatus in which the crude gas from the retort is cooled, and the ammoniacal liquor and tar extracted therefrom. See GAS-CONDENSER.

5. (*Sugar Manufacture.*) The Degrand (Derosne) condenser is in the train of sugar apparatus, and consists of a vertical series of convoluted steam-pipes *C*, over which trickles the sugar-cane juice from the defecator. See Fig. 1421.

6. (*Wool Manufacture.*) A device used in wool manufacture to compact the narrow slivers from a carding-machine so as to bring them into the condition of *slubs*. The narrow circumferential cards of the doffing-cylinder deliver narrow slivers which pass to the *condenser*.

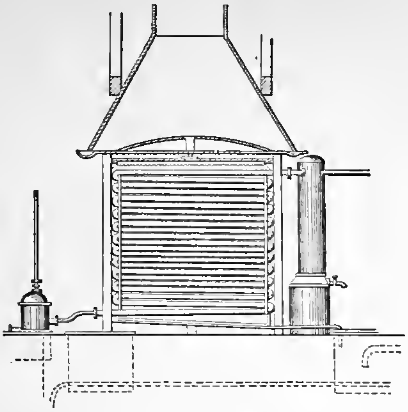
This consists of a pair of transverse rollers supporting a belt as wide as the doffing-cylinder is long, and receiving the slivers which are detached from the card-rings of the said cylinder by the doffing-knife. As the slivers pass from the doffer they run beneath an upper roller, which, in addition to its rotary motion, has an endways motion of two inches, back and forth in the direction of its length. By this means, each sliver is rolled upon the traversing belt in a manner similar to that of rolling it beneath the palm of the hand upon a table. It is thus

Fig 1420.



Dry Distillation Furnace and Condenser.

Fig. 1421.



Derosne Condenser.

rounded and compacted, the fibers becoming somewhat interlaced and closely associated, the nature of the wool tending materially to assist the operation. The endways motion of the roller is given by an eccentric at one end. The slubbings, as they are formed, are carried forward by the apron and wound upon a revolving bar; when filled, this is removed and placed in the mule, which draws from it as it would from bobbins placed on skewers on a creel.

7. A dentist's tool for packing foil for plugging teeth.

8. An air-pump for filling a chamber with air or gas at a pressure above the atmospheric. The condensing air-pump was known to Ctesibus, and figures largely in the "Spiritalia" of Hero.

9. (*Optics.*) A lens to gather and concentrate the rays collected by the mirror and direct them upon the object. There are several varieties, known as the *achromatic condenser*, etc. See CONDENSING-LENS.

10. (*Electricity.*) *a.* An instrument for concentrating electricity by the effect of induction. It usually consists of a confolded sheet of tin-foil, whose layers are separated by a thin sheet having a non-conducting surface.

Volta's electrical condenser is attached to a gold-leaf electrometer, and consists of two brass plates, one connected to the cap of the electrometer, the other supported on a brass pillar. The use of the instrument is to render apparent such portions of electricity as are too weak to be indicated by the electrometer only.

b. With induction apparatus, it is a device for absorption or suppression of the extra current, induced by the rapid breaks in the main current.

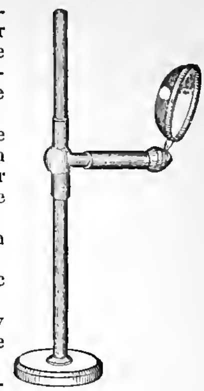
c. An instrument in which an electric spark passes between the poles in a closed glass cylinder, so as to be employed in burning metals in an atmosphere of any given tenuity or specific chemical character, to obtain the spectra of metals or gases free from accidental characteristics of the general atmosphere for the time being. A *spark-condenser.*

Con-dens'er-gage. A tube of glass, thirty-two inches long, open at both ends, the upper end being fixed to the condenser, the lower end dipping into mercury. It is to ascertain the degree of exhaustion in the steam-condenser.

Con-dens'ing-lens. A plano-convex (*bull's eye*) or double convex lens, to concentrate rays upon an opaque microscopic object.

Con-dens'ing-en'gine. (*Steam-engine.*) One

Fig. 1422.



Condensing-Lens.

in which the steam below or in advance of the piston is condensed, in order that a power equal to the cumulative force of steam and atmospheric pressure may act upon the effective side.

In contradistinction to the non-condensing engine, in which no provision is made for a partial vacuum in advance of the piston.

The object of condensation is twofold: —

To avail the atmospheric pressure.

To economize the fuel by making effective a part of the otherwise escaping heat.

Among the condensing-engines may be cited: — The *Cornish* and *marine engines* of various kinds. *Pumping* and *factory engines* of large size are usually *condensing.*

The engines of the Eastern rivers and Northern lakes are usually *condensing.* Those of the Western and Southern rivers are usually *high-pressure* and non-condensing. The latter of a given power are lighter than the condensing, and the depth of water often determines the question, which kind of engine shall be adopted in a country or district.

Locomotives belong to the *non-condensing* class, securing compactness and power within moderate limits as to weight.

Con-dens'ing-syr'inge. A syringe whose valves are so arranged as to take air above and condense it below the piston, so as to condense air into any chamber to which the foot of the syringe is secured.

Con-duct'or. 1. (*Electricity.*) A term applied to a body capable of transmitting an electric current. Strictly speaking, all bodies are conductors of electricity, but those of relatively very small conductivity are known as non-conductors; for instance: —

The conductivity of copper being estimated at 40,000,000,

That of water is as 1.

Becquerel's table is as follows: —

Pure copper wire	100
Gold	93.6
Silver	73.6
Zinc	28.5
Platinum	16.4
Iron	15.5
Lead	8.3

In practice: A *prime* conductor collects and transmits the *frictional* electricity of the electrical machine. It was introduced by Bose in 1741.

A *lightning*-conductor, for conducting the *static* or *tension* electricity of the atmosphere harmlessly to the earth. It consists of a wire, rod, or slip of metal from the top of a house, tower, steeple, or mast, to the ground, or, better still, a ground-plate or system of buried iron pipes.

Gray and Wheler, in 1720–1736, made experiments to ascertain the distance through which electric force could be transmitted, using insulated metals.

Gray, in 1729, discovered the properties of electric conductors. "He found that the attraction and repulsion which appear in electric bodies are exhibited also by other bodies in contact with the electric." — WHEWELL.

Dr. Watson, in 1747, passed transmitted electricity through 2,800 feet of wire and 8,000 feet of water, using the earth circuit.

Benjamin Franklin, in 1748, performed his experiments on the banks of the Schuylkill, "concluded by a picnic, when spirits were fired by an electric spark sent through the river, and a turkey was killed by the electric shock, and roasted by the electric jack, before a fire kindled by the electrified bottle." The latter was the Leyden jar, the invention of Muschenbroek and Kleist, three years previous.

Franklin flew his kite in Philadelphia in 1752, and proved the substantial identity of lightning and frictional electricity. He then invented the lightning-rod for the harmless passage of the electricity.

D'Alibard erected a lightning-rod in the same year.

Richmann of St. Petersburg, the following year, in repeating Franklin's experiment, was killed by a stroke of lightning.

Charles Marshall, in 1753, proposed insulated wires, suspended by poles, as electrical conductors for transmitting messages.

Lesarge, in 1774, used twenty-four electrized wires and a pith-ball electrometer as a mode of signaling. Lomond, in 1787, used one wire and a pith-ball.

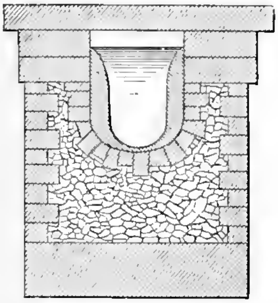
Reizen, in 1794, had twenty-six line wires and letters in tin-foil which were rendered visible by electricity.

Cavallo, in 1795, had one wire, and talked by sparks. He had an explosion of gas for an alarm.

2. (*Surgical.*) A grooved staff for directing a penetrating instrument in surgical operations; such as the forceps in extracting balls; lithontriptic instruments, etc.

Con'duit. (*Hydraulic Engineering.*) A pipe or passage, usually covered, for conducting water.

Fig. 1423.



Conduit of the Pont du Gard.

Cone. The vent-plug which is screwed into the barrel of a fire-arm (*A*, Fig. 1424). The outer end is the *nipple* for receiving the percussion-cap.

a, nipple.
b, square.
e, shoulder.
d, screw-thread.
c, vent.

Cone-bit. A boring-bit of conical form.

Cone-com'pass-es. A pair of compasses with a cone or bullet on one leg, to set in a hole. A *bullet-compasses.*

Cone-gear. A mode of transmitting motion, consisting of two cones rolling together.

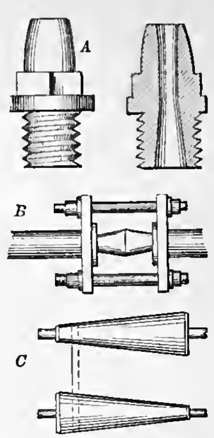
Cone-joint. A joint (*B*, Fig. 1424) formed by a double cone of iron inserted into the ends of the pipes to be joined, and tightened by screw-bolts, as shown in the figure.

This joint is quickly made and is very strong.

Cone-plate. The conical collar-plate of a *lathe-head.*

Cone-pul'ley. 1. An arrangement for varying the speed of the bobbin in spinning-machines, giving them a gradually decreasing velocity as the roving is wound thereon, so as to keep an equal strain on the roving (*C*, Fig. 1424). The lower pulley is driven with a uniform speed, and communicates motion to the other by a band which is slipped towards the larger end of the upper roller as the roving gradually fills the bobbin. See Fig. 751. The object is to obtain an equal pull on the roving, notwithstanding changes in the diameter of the *cop* as the winding proceeds.

Fig. 1424.



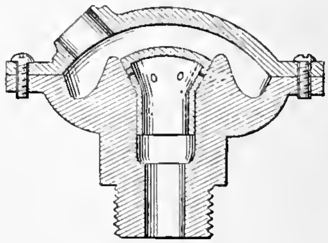
Cone-Pulley.

2. (*Machinery.*) A pulley with several faces of varying diameter, so as to obtain varying speeds of the mandrel. A *speed*-pulley.

Cone-valve. A hollow valve having a conical, perforated face, through which water is discharged when the valve rises, without impinging directly upon the valve-face or seat.

Cone-vise Coup'ling. A mode of connecting the ends of shafting, consisting of an outer sleeve *a* and two inner sleeves *b b*. The interior surface of portion *a* has two conical frustums, and the inner sleeves have gains for the bolts *c c*, which draw them together and jam them between the inclines of the outer sleeve and the surfaces of the respective rods.

Fig. 1425.

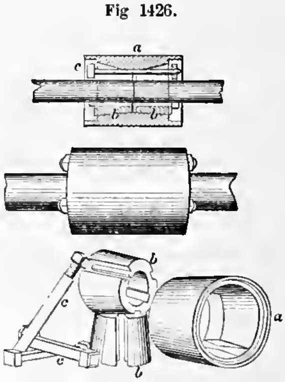


Cone-Valve.

Cone-wheel. The cone-wheel has several applications: —

1. Two frustums are in apposition, one having teeth on its face and the other a spirally arranged row of studs. The toothed wheel at its small end acts upon studs on the larger portion of the opposite wheel and conversely. The effect is to confer a regular variability of rotation to the stud-wheel from a regular rotation of the driving-frustum.

Fig 1426.

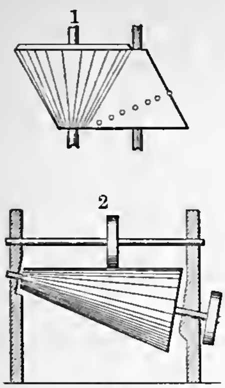


Cone-Vise Couplings.

2. The frustum, being driven by the motor, communicates motion to the wheel above it. This is not intermittent or variable, but is adjustable. The nearer the upper wheel is to the base of the cone, the faster will it rotate, and conversely.

Con-fec'tion-pan. A pan for making comfits or other confections which require to be rolled upon one another while being dried by heat. In the example, the shaft of the pan is secured to a ring by a universal joint. Its lower end rests in a socket made on the upper face of the wheel, which is rotated by

Fig. 1427.



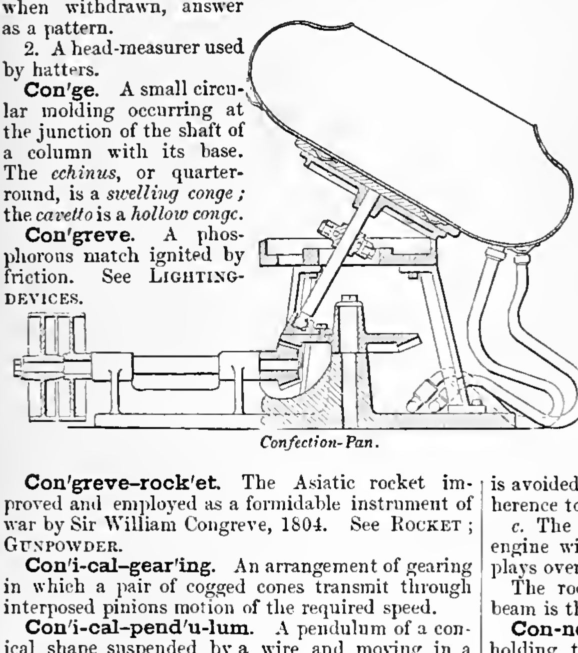
Cone-Wheels.

gearing, and carries the shaft around with it, giving a wabbling motion to the pan. The shaft describes two cones connected at their common vertex, which is at the center of oscillation in the universal joint. A rolling motion is imparted to the pan, which is heated by steam or hot-air pipes beneath, communicating by flexible pipes with a furnace or boiler and an escape-pipe.

Con-form'a-tor. 1. A skeleton frame of slats and braces, adaptable to the person, and then, after adjustment, removable, so as to be laid upon cloth and allow the pattern to be marked thereon. Or an elastic jacket with points on the seams, upon which a paper may be impaled, and, when withdrawn, answer as a pattern.

2. A head-measurer used by hatters.

Fig. 1428.



Confection-Pan.

Con'ge. A small circular molding occurring at the junction of the shaft of a column with its base. The *echinus*, or quarter-round, is a *swelling conge;* the *cavetto* is a *hollow conge.*

Con'greve. A phosphorous match ignited by friction. See LIGHTING-DEVICES.

Con'greve-rock'et. The Asiatic rocket improved and employed as a formidable instrument of war by Sir William Congreve, 1804. See ROCKET; GUNPOWDER.

Con'i-cal-gear'ing. An arrangement of gearing in which a pair of cogged cones transmit through interposed pinions motion of the required speed.

Con'i-cal-pend'u-lum. A pendulum of a conical shape suspended by a wire and moving in a circular path in a horizontal plane. See PENDULUM.

. A term sometimes applied to the rotating ball governor.

Con'i-cal-pul'ley. *Conical-pulleys* are used in cotton machinery where a gradually increasing or decreasing speed is required. See CONE-PULLEY.

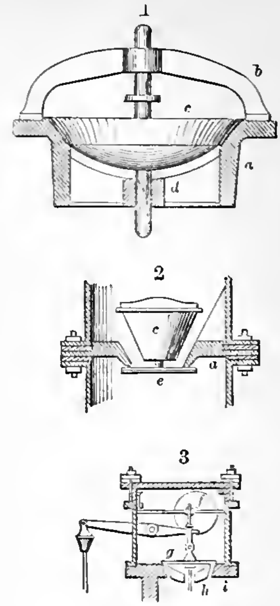
Con'i-cal-valve. 1. A form of valve for water and steam engines. *a* is the valve-seat, made tapering so as to fit into the valve-chamber of a pump. Upon the rim of this is fixed the bridge *b*, serving both as a guide and a stop for the valve *c*, whose lower stem enters the sleeve *d*.

2 shows a conical frustum *c* having a stem in the bridge-piece *e* and a seat *a*.

3 shows Watt's conical valve *g h*, with a stem in the bridge *f*, and operated by a lever and cord.

Con'i-cal-wheel. A wheel shaped like a frustum of a cone, and used in many ways: as a roller for turning curves in moving heavy bodies; the cone-pulleys are forms of wheels for changing speed; used in spinning-machines and lathe-heads; the fusee is a conical-wheel with a spiral track for the chain.

Fig. 1429.



Conical Valves.

Co-nis'si-net. The stone which crowns a pier, or that lies immediately over the capital of the impost, and under the sweep.

Con-nect'ing-link. A link which has a movable section by which it may be made an intermediate connection between two links of a broken chain. The *open*-ring or *lap*-ring is a form of connecting-link used in attaching a single-tree to a double-tree, and the latter to the plow-clevis.

Con-nect'ing-rod. (*Machinery.*) *a.* The rod connecting the piston-rod or cross-head of a locomotive engine with the crank of the driving-wheel axle.

b. The coupling-rod which connects driving-wheels on the same side of a locomotive. By coupling other pairs of driving-wheels to the pair which is immediately actuated by the engines, slip is avoided, as a greater number have a tractive adherence to the rails and are not mere bearers.

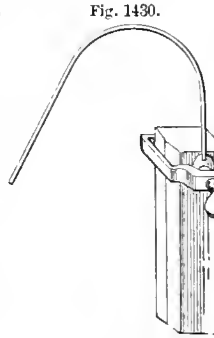
c. The rod connecting the cross-head of a beam-engine with that end of the working beam which plays over the cylinder.

The rod depending from the other end of the beam is the pitman or pump-rod, as the case may be.

Con-nect'or. 1. (*Electricity.*) A device for holding two parts of a conductor, as the two wires for instance, in intimate contact. A *binding-screw;* a *clamp.*

2. The English term for a car-coupling.

Fig. 1430.



Connector.

Con'science. A plate resting against the drill-head and enabling the pressure of the breast or hand to be brought upon the drill. A *palette.*

Con'sole. (*Building.*) A bracket whose *sole* or shelf is supported by a pair of flowing scrolls.

Con′stant Bat′ter-y. A name applied to the Voltaic battery of Professor Daniell, in which the zinc is separated from the copper by a porous diaphragm, such as bladder or unglazed porcelain, two distinct liquids being used. The part of the battery containing the zinc is charged with dilute sulphuric acid, and the part containing the copper is charged with sulphate of copper. See GALVANIC BATTERY.

Con-struc′tion-way. (*Railroading.*) As distinguished from the finished or *permanent* way of a railroad. It is a temporary way used in transporting the gravel, etc., of the *cuttings* to the *fills* or places where the embankments are to be made. Also in obtaining gravel from other points where the cuttings for the track do not furnish it.

Also used in transporting material and men to the point at which the work is progressing and in carrying ballast for the track.

Con′tact-lev′el. A valuable adaptation of the spirit-level used by certain instrument-makers for the production of exact divisions of scales, and generally for the determination of very minute differences of length.

This device was invented about the year 1820, by Repsold, a celebrated instrument-maker of Hamburg, whose mechanical genius first manifested itself in the repairing of chronometers while he was mate of a vessel at sea.

It consists of a very delicate level pivoted at its middle and across its length, with a small tilt-weight at one end, which tips always in one direction. From the center of the level downward, a short rigid arm extends with a plain polished surface perpendicular to the chord of the level, and against which the contact is made. The carrier of this arrangement is either fixed, or mounted on a slide, governed by a micrometer screw. If now the end of a rod terminating in a hardened steel point be advanced horizontally till it bears against the contact-arm, the level will gradually assume the horizontal position, and the movement of the bubble as indicated by the scale upon the glass will depend upon the relation between the radius to which the level-tube is ground, and the length of the contact-lever. If the latter is $\frac{1}{2}$ an inch long, and the radius of the glass tube is 400 feet (levels for astronomical purposes are ground to a sweep of 800 and 1,000 feet radius), we have the relation between the lever and radius as 1 is to 9,600, and as $\frac{1}{50}$ of an inch can readily be read from the level-scale, $\frac{1}{480000}$ of an inch (9,600 × 50) will be the difference in length which each division on such a scale indicates.

When it is remembered that such a determination of length can be repeated indefinitely, and that the readings are made without the aid of a magnifying-glass or artificial illumination, the perfection and beauty of the method will be appreciated.

Con-tin′u-ous Rail. A rail made in sections with a longitudinal vertical joint, and the sections laid together, breaking joint.

The continuous rail has been tested on the New York Central Railroad and on other American lines. Its smoothness of action left but little to be desired while it was new, but it soon deteriorated. The rail is made in sections which have a longitudinal vertical joint; the parts being united by bolts and nuts, with the addition of *fish-plates* at the transverse joints. The sections *break joint*, that is, the junction of two pieces on one side comes opposite to an unbroken surface of the rail on the other side. See FISHING.

Cont′line. The space between the strands on the outside of a rope. In *worming*, this space is filled up with spun yarn or small rope, which brings the rope so treated to a nearly cylindrical shape, either to strengthen it or to render the surface smooth and fair for *serving* or *parceling*.

Con-tour′. (*Fortification.*) *Natural contour:* the form of the ground surface with respect to its undulations.

Line of contour: a horizontal plane intersecting a portion of ground.

Con′tra-bas′so. (*Music.*) The largest and deepest-toned of the series of stringed instruments played with the bow. A *double-bass.*

Con-trac′tion-rule. A rule in excess of standard measurement used by pattern-makers, to allow for the contraction of the cast metal in cooling.

Con′tra-mure. An out-wall built about the wall of a city or fortification.

Con′trate-wheel. A *crown*-wheel or *face*-wheel, in a watch. Also known as the *fourth* wheel. Its cogs project perpendicularly to the plane of the wheel. It gave a name to the old *vertical* or *verge* movement, in clocks and watches, where a crown-wheel is placed in engagement with the pinion on the arbor of the escape-wheel, in order to bring into horizontal position in the clock the arbors of all except the escape-wheel. The *anchor* pallet has put the contrate-wheel out of use in clock escapements, and the lever and other movements have superseded the old *vertical* movement in watches.

Con′tra-val-la′tion. (*Fortification.*) An advanced offensive work consisting of a trench and parapet to check sallies of the garrison.

Con′tra-va′peur. A French invention, a partial substitute for brakes. It consists in injecting a small stream of water from the boiler into the exhaust-pipes or passages before and during the reversal, so as to bring a counter-pressure of steam upon the piston.

Con-trol′ler. (*Nautical.*) A cast-iron block having depressions on its upper surface adapted to fit the links of the cable which passes over the block on its way from the locker to the hawse-hole.

Controllers are bolted to the deck at various points in the line traversed by the cable. The latter tends to drop into the hollow of the block which then arrests the motion. The cable may be lifted out of the hollow, by the short arm of a lever which rises from the bottom of the hollow in the block.

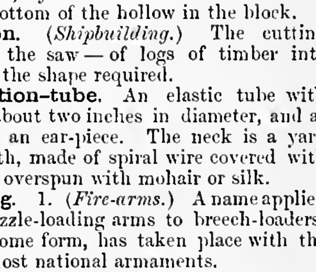
Con-ver′sion. (*Shipbuilding.*) The cutting — usually with the saw — of logs of timber into pieces nearly of the shape required.

Con ver-sa′tion-tube. An elastic tube with a mouth-piece about two inches in diameter, and at the other end an ear-piece. The neck is a yard or more in length, made of spiral wire covered with caoutchouc and overspun with mohair or silk.

Con-vert′ing. 1. (*Fire-arms.*) A name applied to changing muzzle-loading arms to breech-loaders, and which, in some form, has taken place with the small-arms of most national armaments.

From among the various competing plans for converting the Enfield rifle of the English service into a breech-loader, that of Snider was adopted. The cost of conversion is about 15*s.* English for each rifle.

Fig. 1431.



Snider's Converted Enfield Rifle.

The method is as follows:—

About two

inches of the barrel are cut away at the breech, and a solid breech-stopper A, working sideways on a hinge, is placed in the opening thus made. Through this stopper passes a piston, one end of which, B, when the breech is closed, receives the blow from the hammer, while the other communicates it to the center of the cartridge, thus firing the latter. The empty cartridge-case is retracted after each discharge by means of sliding back the stopper on its pintle, when the tilting of the piece tips out the shell and another can be inserted. It weighs 9 pounds 5¼ ounces, and has been fired fifteen times in a minute.

The Springfield (U. S.) rifle is also *converted* into a breech-loader. See FIRE-ARM.

2. *Rasing*, or reducing a ship by a deck; or otherwise changing or degrading it into a battery-vessel, or a receiving or prison hulk.

3. Decarbonizing, or changing cast-iron into steel. See CONVERTOR; BESSEMER PROCESS.

Con-vert'ing-fur'nace. One for converting wrought-iron into steel. Wrought-iron is iron in its greatest purity, though it is seldom that all the impurities are perfectly eliminated. Steel contains a portion of carbon, more or less, and is a carburet of iron. Cast-iron contains a much larger amount of carbon. Qualities of each depend upon the quantity and nature of other matters which are combined with the iron, some being undesirable but difficult of removal, and others being purposely added to confer a quality or to neutralize extraneous matters which are present.

The bars of iron are cut by shears to the required length and are placed in layers in a flat, narrow furnace, with intervening layers of pounded charcoal. Above the alternate strata of iron and charcoal is a covering of ferruginous earth. The mass being heated, the carbon is in some way absorbed by the iron, which is converted into steel. This is known as CEMENTATION (which see).

The resulting *blister* steel, so called from the blisters formed by bubbles of gas which was eliminated during the process of conversion, is then cut up, reheated and hammered, and becomes *shear* steel.

Blister steel, cut up, heated in crucibles, poured into molds, and the ingots hammered into shape, becomes *cast*-steel.

Con-vert'or. An iron retort in which molten iron is exposed to a blast of air, the oxygen of which burns out the carbon and some other impurities of the iron; a subsequent addition to the charge makes a further chemical change, and the result is a grade of steel. It is used in the Bessemer process.

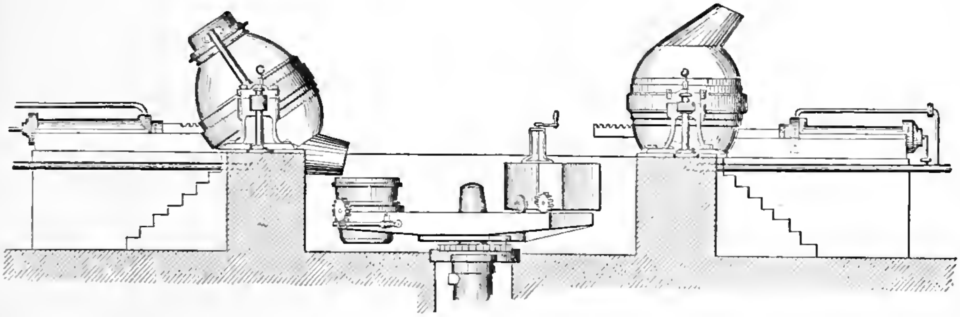
Condensing, from a brilliant description by Mr. R. W. Raymond of the process as conducted by Mr. Holley, it may be briefly described as follows: —

The five-ton convertor is an iron vessel 14½ feet high and 9 feet in diameter externally, of a bulbous shape, and hung upon trunnions. The lower hemisphere is truncated, giving a flat bottom, five or six feet in diameter. The upper hemisphere terminates in a large neck inclined sidewise, so that a flame issuing under pressure from the mouth of the upright convertor is obliquely directed into a chimney, guarded by a hood. The whole vessel has a rude resemblance to a pear. It is supported by heavy trunnions on each side of the center, and revolved upon these by hydraulic power.

This huge iron bottle, with its neck awry, is lined with a foot of refractory silicious material, known as *ganister*, to preserve the iron shell. The trunnion is hollow, and a passage from it runs down the outside, looking like a strong rib in the iron surface, to the bottom, where it communicates with the tuyeres. The bottom of the Holley convertor is movable, and when taken out looks like a great plug of fire-brick, two feet high, resting upon a cast-iron disk. The tuyeres, or nozzles for the blast, are imbedded vertically in the lining, and present ten groups, each containing a dozen three-eighths inch holes. The aggregate area of these openings is equal to that of a single tuyere 4.1 inches in diameter, but the thorough agitation produced by dividing the blast secures much greater useful effect. The pressure of the blast is twenty-five pounds per square inch.

The convertor in its upright position, being heated by a charge of coals and the blast, is turned mouth downward to vomit out the glowing coals, then upon its side to receive its charge, which runs from the cupola furnace above, along a trough, and plunges into the mouth of the convertor. The position of the retort at this time prevents the charge from running into the tuyeres before the blast begins. Afterwards the pressure of the air itself keeps the passages clear. Then the blast is let on, and the convertor swung back to a vertical position. A tongue of white flame comes roaring out of the

Fig. 1432.

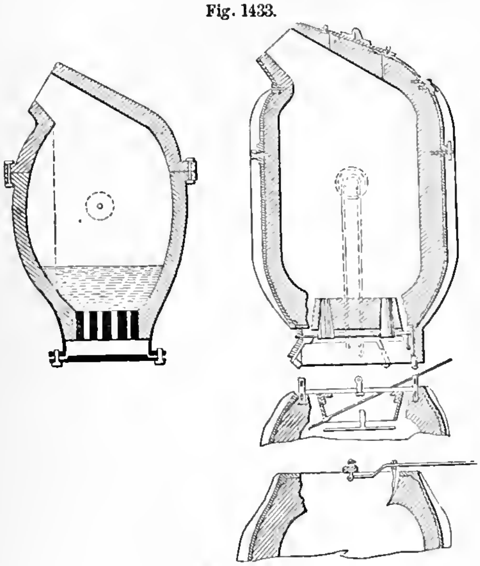


Convertor.

mouth. The silicon of the pig oxidizes first, without very intense flame; but as the graphite and especially the combined carbon begin to burn also, the heat rises to some 5,000° F., and the light is so brilliant as to cast shadows across full sunshine.

In fifteen or twenty minutes the marvellous illumination ceases more suddenly than it began. The volume and brilliancy of the flames diminish together with startling rapidity. This change of the Bessemer flame marks the elimination of most of the carbon, and indicates the critical moment. When it arrives, the blast is stopped, the convertor is turned upon its side, and 600 pounds of melted spiegeleisen are turned into it, as the pig was previously charged. The reaction is instant and violent. The manganese of the spiegeleisen combines with any sulphur that may remain in the bath, forming compounds which pass into the slag. It also decomposes in the slag silicates of iron, taking

Fig. 1433.



Holley's Convertor.

the place of the iron and returning it to the bath. Finally, the carbon and manganese together reduce the oxide of iron formed during blowing, which would destroy the malleability of the iron. This is quickly accomplished, and now the gigantic convertor, like a monster weary of drinking boiling iron and snorting fire, turns its mouth downward, and discharges its contents into a vast kettle or ladle, brought underneath for the purpose by one of those intelligent cranes that stand around so silent and so helpful. The ladle is swung over the molds ranged round the side of the semicircular pit below, like a row of Ali Baba's oil-jars, each capable of containing a bandit. The white, one would almost say transparent, metal is drawn off into these through a tap-hole in the bottom of the ladle, retaining the slag which floats on the surface till the last. When the first mold is filled, the plug is closed, the ladle swung round to the second mold, and so on till all the steel is thus cast into ingots, the size of which varies with the kind of work for which the steel is required. A thin steel plate is placed on the top of each casting immediately the mold is filled, and over this a bed of sand is placed, and speedily and firmly pressed down.

As soon as the ingots have solidified, and while they are still glowing, the molds are lifted off them by means of an hydraulic crane, and afterwards the ingots are picked up by tongs attached to the same machinery, and are carted away, all red-hot, to the hammer-shops, where they are thumped and rolled or otherwise tortured into their required forms of rails, tires, and plates.

Con′vex Lens. One having a protuberant form.

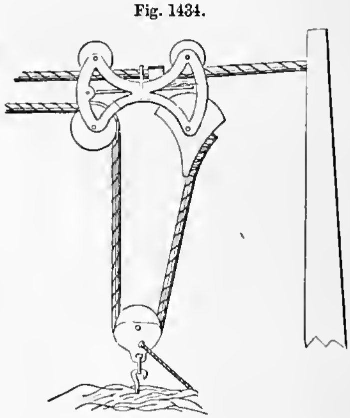
A *plano-convex* lens has one flat and one bulging side.

A *concavo-convex* or *convexo-concave* has one protuberant and one depressed side.

A *convexo-convex* or *double-convex* has two convex surfaces, not necessarily of the same radii. See Lens.

Con-vey′or. A mechanical means of carrying objects. A term applied usually to those adaptations of band-buckets or spirals which convey grain, chaff, flour, bran, etc., in thrashers, elevators, or grinding-mills; or materials to upper stories of warehouses or shops, or buildings in course of erection. (See Elevator.) Also applied to those arrangements of carriages traveling on ropes, by which hay lifted by the horse-fork is *conveyed* to distant parts of a barn or mow (Fig. 1434); or materials to a structure, as shown in the full-page cut opposite to page 49.

Fig. 1434.

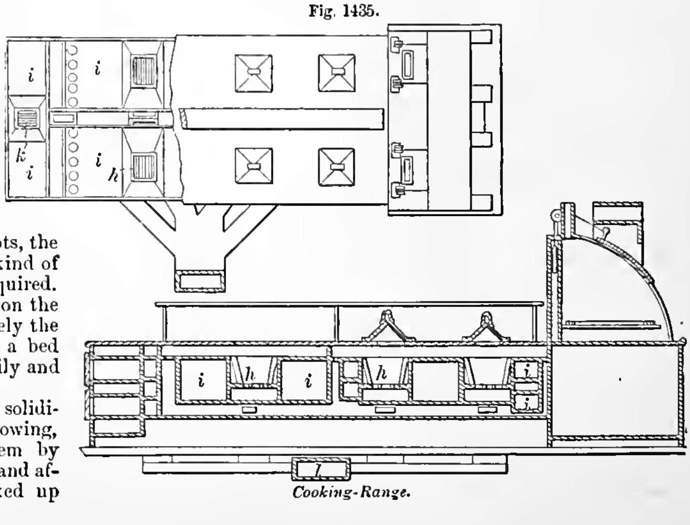


Hay Elevator and Conveyor.

Con′voy. One name of a friction brake for carriages.

Cook′ing-range. A cooking arrangement in which the devices — grate, oven, boiler, etc. — are placed in a row (ranged), and set in brickwork within the fireplace, so called. Portable ranges are not so built in, but are cooking-stoves. One of the

Fig. 1435.

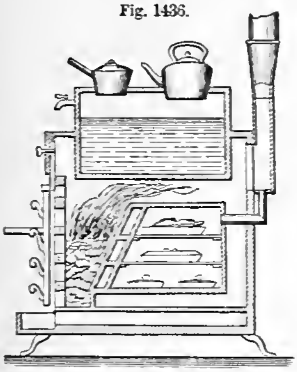


Cooking-Range.

latter kind, for hotel or steamboat use, is shown in Fig. 1435, in which the fire-chambers *h h k*, ovens *i i*, and flues, are so arranged that the range has two fronts and an end, so that attendants can have ready access to all parts of the range. The products of combustion are utilized in heating closets below the ovens for warming plates and keeping the viands warm, and thence dive into the sub-floor flue *l*, which connects with the chimney of the building.

Cook'ing-stove. A structure, usually of iron, containing a fuel-chamber and ovens, with boles into which pots may be set to boil the contents.

Fig. 1436.

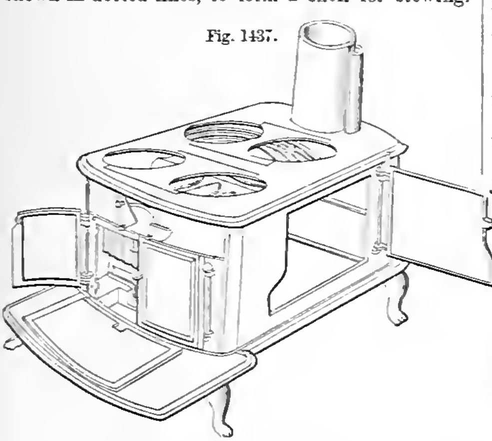


English Stove.

Stoves are comparatively uncommon in England. They prefer the open fireplace for apartments and the range for kitchens. See RANGE.

The English cook-stove of forty years since is shown in the annexed cut. The front of the stove is a grate at which joints may be roasted. Between the fire-back and the oven is an air-flue. A part of the front may be lowered, as shown in dotted lines, to form a shelf for stewing.

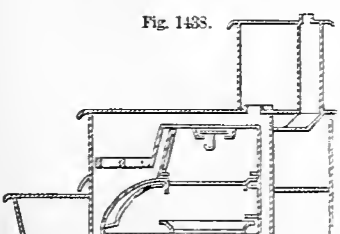
Fig. 1437.



American Cooking-Stove.

A plate may be in front to form a blower. The fire is directed above or below the oven by means of dampers. The passage between the fire and the oven is supplied by air from below, and discharges into the oven, from whence a pipe discharges the fumes of the cooking into the chimney. This is said to have the effect of roasting rather than baking.

Fig. 1438.

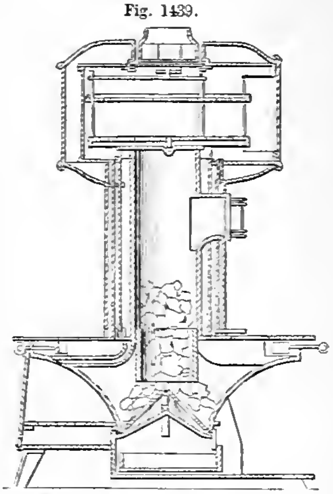


Roasting-Stove, with Reservoir.

Fig. 1437 represents an ordinary form of stove, the doors being opened and lids off to expose the interior.

Fig. 1438 is an attempt to secure a roasting-stove by means of direct radiation from the fire-box into the oven through the back fire-plate and the front oven-plate for roasting or broiling; but this direct radiation is shut off when the oven is used for baking.

Fig. 1439.



Elevated-Oven, Base-Burning Cooking-Stove.

Fig. 1439 has an elevated oven and a coal-magazine, being an application of the base-burning principle to the cooking-stove. The base is connected by vertical flues to the upper part containing the oven. There are many hundreds of varieties; some differences being actual, some imaginary.

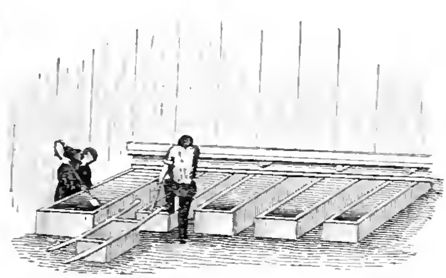
Cool'er. 1. (*Brewing.*) A large vat, relatively broad and shallow, in which the beer is cooled. Mechanical appliances are sometimes used to expedite the process. See LIQUID-COOLER; BEER-COOLER.

2. (*Domestic.*) *a.* An ice-chest or safe for viands in hot weather. See REFRIGERATOR.

b. A tin vessel with lid, faucet, and non-conducting jacket, for containing ice-water.

3. (*Sugar.*) A trough in which condensed cane-juice from kettles or vacuum pans is placed to crystallize. In Cuban sugar-houses each cooler holds 1½ hogsheads.

Fig. 1440.



Sugar-Cooler.

Cool'ing-floor. A large shallow tank in which *wort* is cooled. Horizontal vanes for causing a circulation of air over the wort are called *flighters.* Apparatus for bringing the wort in contact with artificially cooled surfaces are REFRIGERATORS (which see).

Coom. A term applied to refuse matters, such as soot, smoke-black, coal-dust, the mold which forms on some liquids, the drip of journal-boxes, etc.

Coop'er-ing. The art of making casks and barrels.

The invention is ascribed by Pliny to the people who lived at the foot of the Alps. It seems to have attained great excellence at an early day.

The business is divided into several kinds, which may or may not be carried on together.

Dry coopering consists of making barrels for flour, hams, eggs, grain, sugar, etc.

Wet or *tight* coopering is for whiskey, molasses, pickled meat, cider, vinegar, etc.

White coopering consists of buckets, tubs, churns, etc.

Bucket-making and *barrel-making* are generally carried on in factories, special machinery being employed.

The accompanying cut gives an impression that the business of coopering is conducted on energetic

Fig. 1441.

Japanese Coopers (from a Native Picture).

principles. While the Hindoo bricklayer sits at his work, and the blacksmith of some other country — name forgotten — holds his tongs with his foot, it appears that in Japan one holds the driver and another climbs upon the trussed cask to use the hammer.

Coop'er's Ham'mer. A hammer with a narrow *peen*, whose length is in the plane of the motion of the hammer; used for battering and flaring an iron hoop to fit the bulge of a cask. Also called a *flue-hammer*.

Coop'er's Plane. A long plane set in slanting position, sole upward, upon which staves are jointed. A *jointer*. Planes and shaves are or may be used in smoothing the work. See list under next article.

Coop'er's Tools: —

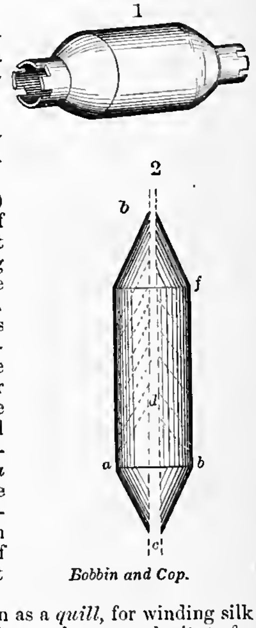
Adze.
Auger. Taper
Barrel-machine.
Barrel-head machine.
Borer.
Bucket-machine.
Bung.
Bung-cutter.
Butt-howel.
Chineing-machine.
Cleaving-knife.
Cooper's hammer.
Cradle.
Cresset.
Croze.
Crozing-machine.
Doweling-machine.
Drawing-knife.
Driver.
Flagging-iron.
Flue-hammer.
Frow.
Gathering-hoop.
Heading-circler.
Heading-knife.
Heading-machine.
Hollowing and backing-machine.
Hoop.
Hoop-bending machine.
Hoop-cutter.
Hoop-dressing machine.
Hoop-driver.
Hoop-punching machine.
Hoop-riving machine.
Hoop-shaving machine.
Hoop splaying and bending machine.
Howel.
Inshave.
Jigger.
Jointer.
Overshave.
Pack.
Pail-machine.
Raising-knife.
Rounding-machine.
Setting-up machine.
Shook.
Spoke-shave.
Stave.
Stave-bender.
Stave-cutter.
Stave-dresser.
Stave-jointer.
Stave-machine.
Stave-sawing machine.
Stave-setter.
Tap-borer.
Truss-hoop.
Turrel.
V-croze.
Vyce.

Coo-thay'. (*Fabric.*) A striped satin made in India.

Cop; Cop'pin. 1. (*Spinning.*) A conical ball of thread wound upon a spindle or tube in a spinning-machine, and removable by slipping therefrom.

The *copping-reel* is the means of distributing the roving or yarn up and down on the bobbin, so as to wind it into the form required. The form (1, Fig. 1442) is the result of a scheme for giving each layer an equal length of yarn, so that the length of the layer on the bobbin shall *decrease* as its diameter *increases*.

Fig. 1442.



Bobbin and Cop.

The increase in diameter renders necessary a decrease in speed, in order that it may wind equal yarn in equal times. This is accomplished by a device called a *cone-pulley* (which see).

The *cop* (2, Fig. 1442) made on the spindles of the mule is of a different form, the yarn being wound in a double cone as a foundation *a b c d*, upon which the rest is built upward in successive layers, which are easily unwound, either by the reel or in the shuttle. The conical *spindle-form* with conical ends is preserved (*a b c e f*), as being the most compact and self-sustaining, consideration being had to the form of the shuttle in which it is to lie.

2. A tube, also known as a *quill*, for winding silk upon in given lengths for market; a substitute for skeins. Being hollow, it may be placed on the spindle or skewer of any winding-machine. The silk end is secured in a slit, as in the case of spools.

Cope. 1. (*Founding.*) The upper part of a mold; the lower is the *drag*. It may consist of several parts, which divide by a vertical joint and mutually rest upon the *drag*. See FLASK.

It is also known as the *cap*, *coat*, *top*, *case*, *dome*. Some of these are mere synonymes, others refer to specific forms of the object.

2. (*Architecture.*) A crown, arch, or arched lintel. The root-meaning is the same as *cap* or *cover*.

Cope-chis'el. A chisel adapted for cutting grooves.

Cop'ing. (*Masonry.*) The top, protecting course on the top of a wall. It is of three kinds: —

Parallel coping, level on top.

Feather-edged coping, bedded level and sloping on top.

Saddle-back coping has a curved or doubly inclined top.

The under edge should be *throated*, that is, grooved, so that the drip will not run back on the wall, but drop from the edge.

Cop'per. 1. A red metal. Equivalent, 31.7: symbol, *Cu.* (cuprum); specific gravity, 8.7 to 8.9, according to density; fusing-point, 1996° F. A moderately hard, malleable, ductile metal. A good conductor of heat and electricity.

Its uses are very numerous. In the shape of wire and sheets its employments ramify through all the uses and conveniences of commerce and the household.

The alloys, brass and bronze, are the most useful of that interesting class of compounds. Besides these, it enters into the composition of albata, bell-metal, speculum-metal, etc. See ALLOY.

Its salts are usually poisonous, but brilliant, and are extensively used in the arts.

It forms the material for the lower denomination of the coins of most civilized nations.

Copper was known and used long before iron. The discovery, so far as the nations depending on the Western Asiatic civilization is concerned, is probably due to the Scythians. Aristotle, Pliny, and others give the names of the supposed discoverers, and carry it back to the era of fabulous divinities. The first alloy of copper was that with tin, making a bronze; afterward with zinc, making a brass. The same name is applied to both in the Greek, also in the Latin. The tin for the alloy was found in the islands called Cassiteris or Cassiterides, which are the Scilly Islands and the promontory of Cornwall. "Midacritus," says Pliny, "was the first who brought tin from thence, and the islands received the Greek name of the metal." Herodotus makes the same statement as to the source of the metal, and the same district is yet rich in tin, and is worked to great profit. The tin brought by the Phœnicians to Solomon to alloy the copper for the vessels of the Temple at Jerusalem made other trips when it was carried to Babylon, returned under Cyrus, was retaken by Antiochus Epiphanes, and was thence scattered, probably in the form of coin.

The references in the Bible to copper are very infrequent, considering it to be the commonest metal they had. It is but twice mentioned, while *brass* (so translated) is mentioned thirty-one times. It should be rendered *bronze*, its alloy being tin, and not zinc.

Copper was in common use in ancient Assyria. No iron was found in the excavations of Khorsabad by M. Botta, who was the first successful explorer of the *tumuli* on the Tigris. Iron armor, inlaid with copper, was found by Layard at Nimroud.

Sheet-copper was made in ancient Egypt,

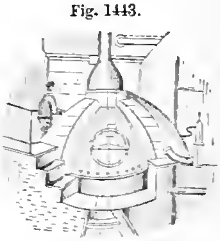
Hesiod speaks of the third generation of men "who had arms of copper, houses of copper, who plowed with copper, and the black iron did not exist." In the Homeric poems, knives, spear-points, and armor were still made of copper.

The process of reducing copper ore depends upon its character. Swansea, in South Wales, has the principal part of the work, ores being brought there from Cornwall, Devonshire, Spain, South America, Australia, Africa, and the United States, and there they are smelted and refined. See COPPER-FURNACE.

The Mansfield (Prussian Saxony) process consists in roasting the calcareous ore to expel the sulphur and oxidize the metal; the ore is then smelted in a cupola, the slag and molten metal being drawn at two tap-holes into separate cisterns. The *matte*, combined sulphurets of iron and copper, is repeatedly roasted, and the resulting sulphate of copper removed by lixiviation. When silver is present, it is removed with lead, and that separated by cupellation.

With the Longmaid process the copper pyrites is roasted in the presence of chloride of sodium. A double decomposition ensues; sulphuric acid is formed and attacks the soda, the copper becomes a soluble sulphate, the iron is in the form of peroxide; the escaping fumes of chlorine impregnate lime, which becomes bleaching-powder.

Fig. 1443.



Brewer's Copper.

The wet treatment of copper is by grinding and roasting; sulphuric acid is formed and attacks the oxide of copper, the resulting sulphate is dissolved away, and the metal precipitated by peroxide of iron.

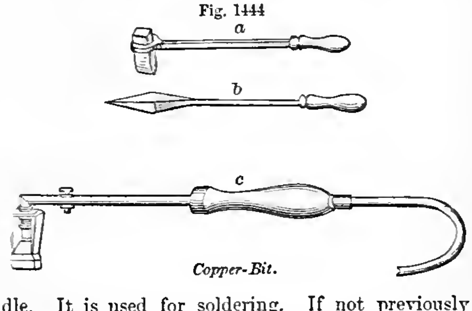
In making sheet-copper the plates of copper from the smelting and refining works are heated, in small ovens called *muffles*, to a bright-red heat, and then repeatedly rolled; the rollers, at each operation, being brought nearer together. The plates thus produced are called *blanks*, which are again heated in the *muffle* and rolled again. A repetition of the process makes *sheet-copper*.

2. A large vessel — usually of copper — set in brickwork, and used by launders, coopers, brewers, bleachers, dyers, and on shipboard; in boiling clothes, staves, cloths, etc., or in making extracts or decoctions.

Cop'per Al-loys'. Copper is the most useful of all metals for alloys, and a list of its combinations is given on page 61 *et seq.*

Cop'per-bit. A pointed piece of copper, riveted to an iron shank and provided with a wooden han-

Fig. 1444



Copper-Bit.

dle. It is used for soldering. If not previously tinned, it is heated to a dull red in a charcoal fire; hastily filed to a clean metallic surface; then rubbed immediately upon a lump of sal-ammoniac, and next upon a copper or tin plate, upon which a few drops of solder have been placed. This will completely coat the tool, which may be wiped clean with a piece of tow, and is ready for use. *a b* show different positions of the bit on its stock.

c is a device by which a gas-jet is applied to the back of the *copper-bit*, admitting of its constant use, without continued reference back to the furnace for reheating. The gas passes through the elastic tube, and thence through the handle and shank, whence it issues in a jet upon the back of the bit, in quantities determined by the stopcock. The elastic tube allows the tool to be moved readily in any direction.

Cop'per-bot'tomed. (*Shipbuilding.*) Having that portion of the outer skin which is exposed to the water sheathed with copper, as a protection against that great bore, the *Teredo navalis.*

Cop'per-cap. The copper capsule, charged with a fulminate and placed on the nipple of a fire-arm, to explode the charge when the hammer falls.

Cop'per-faced. (*Type.*) Having a face of copper upon a shank of type-metal.

Cop'per-fast'ened. (*Shipbuilding.*) Having the planks, etc., fastened with copper bolts, in contradistinction to iron; the latter being liable to rust, especially in contact with oak and by exposure to wet.

Cop'per-fur'nace. Copper-smelting, as practiced at Swansea, Wales, consists of the following processes: —

1. *Calcination of the ore.* This is conducted in a reverberatory furnace. (See CALCINING-FURNACE; COPPER.) The charge is introduced by hopper on to the hearth of the furnace, where it is exposed for 11½ hours to a flame, which disengages the sulphur and arsenic in a gaseous shape.

2. *Separation of the copper from gangue and oxide of iron.* This is accomplished in a melting-furnace, which collects the copper in a *matt*, consisting of sulphuret of copper and iron, the gangue and oxide of iron in the shape of scoriæ, and drives off certain amounts of sulphur and other volatile matters.

Each charge is in the furnace four hours. The *matt* collects in the basin of the hearth, and is run off into a cistern, whereby it is granulated. The scoriæ is run off into sand-pits of small size, where it forms bricks, which are examined for traces of copper and the richer portions retained for remelting.

The copper is in the condition called *coarse metal.*

3. *Calcination of the coarse metal.* This is performed in a reverberatory furnace, the heat being gradually increased for 36 hours. The copper here reaches the condition of *calcined coarse metal.*

4. *Oxidation and removal of the iron.* To the product of the former operation are added certain copper ores free from sulphuret of iron. By melting in connection therewith, the sulphuret of iron is oxidized and passes into the slag, while the copper becomes a *matt*, in the condition of *white metal.* The charge is six hours in the furnace.

5. *Remelting and refining the matt.* By the application of heat in a furnace the reactions of the former operations are repeated; disengaging sulphurous acid, setting copper free to unite with the *matt*, and removing iron, which passes from the condition of sulphuret to an oxide and passes into the scoriæ.

The product is known as *blue metal.*

6. *Remelting of slags.* The slags resulting from operations 4, 7, and 8, are mixed with certain other ores in a furnace, and several chemical reactions take place, which result in two metallic products for future operations, — *red* and *white* metals.

7. *Refining of the blue metal.* The *blue metal* of operation 5 is slowly calcined, and then fused at a high temperature, the first part of the operation taking 8¼ hours, and the second 2½ hours. The reactions are to some extent repetitions of the former, and the product is *white metal.*

8. *Refining of former metallic products.* The *white metal* of operation 7, and the *red* and *white* metals of operation 6, are calcined and then refined, producing a rich *regulus* of copper, a rich slag, and bottoms.

9. *Combining and refining of former metallic products.* The *white metal*, *regulus*, and *bottoms* of former operations are calcined and fused, some rich ore being added. The product is metallic copper and a rich slag, which goes back to the operation 4. The product is known as *coarse copper.* It is run into pigs. Time required, 24 hours.

10. *Converting the coarse copper into malleable.* The *coarse copper*, in the form of pigs, is placed in the furnace; about 21¾ hours being employed in bringing it to that condition where the slag on the surface containing the metallic oxides is skimmed off. It is then called *dry*, and is in a condition which would be brittle, were it withdrawn. It is rendered malleable by carbonizing, charcoal and green wood being thrown on the surface. It is then ladled out and poured into molds.

Cop'per-plate En-grav'ing. A very ancient art; in chasing or enchasing — that is, carving on metal — it is seen in all the regions of antiquity, in the ages of copper and bronze, before iron was used. Many thousands of years passed before the plates ornamented by the graver were used for printing, and even then it was suggested by taking proofs of inlaid or chased work. An artist would take impressions of his work for purposes of transfer or reference, and from these came the suggestion of making the engraving in such a manner that the impression itself might be beautiful and worth keeping for its merits, other than as a workman's copy.

In copper-plate engraving the lines are etched, or cut by a graver in a plate; then filled with an ink; the surface of the plate wiped clean; the paper laid upon the surface of the plate, and both run through a roller-press, by which the ink is transferred to the paper.

Vasari ascribes the invention of engraving on copper to a goldsmith of Florence named Maso Finiguerra, about 1460. The oldest engravers whose names and marks are known were Israel de Mecheln, of Bokholt, in the bishopric of Munster; Martin Schoen, of Colmar, in Alsace, where he died 1486; Michael Wolgemuth, of Nuremberg, the preceptor of the famous Albert Durer.

Cop'per-plate Print'ing-press. This press is for obtaining impressions from sunken engravings; that is, those in which the design is cut *into* the copper or steel plate, in contradistinction to such as have the design salient, as in wood-engravings, where the part which is not designed to print is cut away.

In copper or steel plate engraving, lines are made in the plate by the graver; by the etching-point, followed with acid; by the etching-point alone (called dry point); and by the diamond point of the ruling-machine, followed with acid.

These lines in the plate, whether fine or heavy, are filled with ink, and the plate is then passed through the press, delivering the impression upon the soft, damp paper above it, the ink adhering to the paper and being withdrawn from the lines of the plate.

To describe the process a little more at length: The plate is laid on a small metallic table heated by a brazier beneath. This is to warm the ink, which is made very thick, and is laid on with a dabber or roller until the lines are all full and the surface covered. The surface of the plate is then wiped off with a cloth, leaving the ink in the lines. This requires dexterity, and the plate is first wiped in one direction and then in another. The bare hand, slightly dried by a little whiting, is then applied to the plate to polish the surface, and, the margin being wiped clean, the plate is laid upon the traversing bed of the press.

The paper for the impression is then laid on the plate, and the workman turns the roller by means of the spokes, drawing the plate and paper between the bed and roller, subjecting it to heavy pressure, and causing the ink to adhere to the paper and leave the lines of the plate. Blankets intervene between the paper and the roller.

When an "India proof" is to be taken, the sheet of fine India paper is first laid on the inked plate, and the *backing* of paper is roughened by dabbing it with the bristles of a stiff brush. It is then laid on the India paper, and the pressure causes the two papers to adhere.

The old-fashioned copper-plate press has a roller moved by the radial handles, and a bed traversing on anti-friction rollers. A great improvement consists

Fig 1445.

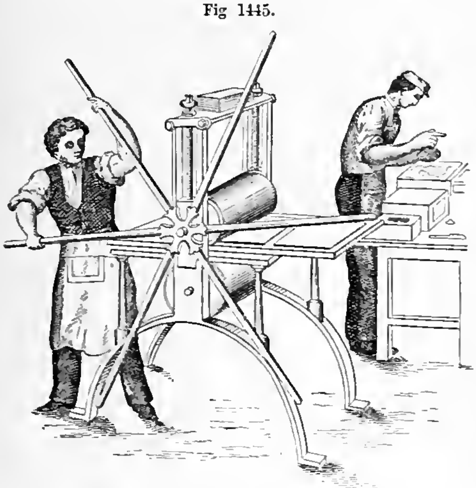


Plate-Press.

in the D-roller, which has one flat side, and allows the bed and plate to return by a counter-weight after passing beneath the periphery of the roller. A farther improvement is the heater in the bed-plate.

The Dutch, Germans, and Italians have contended for the honor of the invention of this press, but it has been awarded to the Italian sculptor and goldsmith, Tomasso Finiguera, a Florentine, who lived about 1460. It is stated to have been suggested to him by the appearance of the impression derived by the accidental pouring of a quantity of brimstone upon an engraved plate, probably engraved for the ornamentation of furniture or some implement or article of *virtu*. The first copper-plate presses were simple pressure. The rolling-press was invented in 1545.

Cop'pin. (*Spinning.*) A *cop* (which see).

Cop'ping-plate. (*Spinning.*) The copping-rail of a throstle-machine.

Cop'ping-rail. The rail or bar upon which the *bobbins* rest in the *bobbin-and-fly* or the *throstle* machine, and by whose up-and-down motion the rooving or yarn is evenly distributed. See BOBBIN-AND-FLY FRAME, or THROSTLE.

Cop-tube. (*Spinning.*) The tube in a spinning-machine on which the conical ball, or *cop*, of thread or yarn is formed.

Cop'u-la. (*Music.*) The stop which connects the manuals, or the latter with the pedals.

Cop'y. 1. A size of writing-paper measuring 20 × 16 inches.

2. Matter for printing.

Cop'y-hold'er. A clasp to hold matter while being set up.

Cop'y-ing-in'stru-ment. A tracing-instrument, or one for multiplying by manifold process.

A silhouette-machine is one for giving, on a reduced scale, the outline of a shadow-portrait.

A photograph is used for copying drawings on a changed scale.

Another mode is by taking an impression on a web of india-rubber, and then stretching it to the desired extent; or else stretching it and taking the impression, and allowing it to contract to the desired extent. In either case the impression may be transferred to the stone by the proper processes.

Cop'y-ing-ma-chine'. A COPYING-PRESS (which see).

Cop'y-ing-pa'per. Thin, unsized paper, used damp, for taking impressions from writings in a copying-press.

Cop'y-ing-press. A machine for taking a copy of a writing by pressure.

The usual system is to write with an ink having a somewhat viscid character, and to expose the written page to pressure in contact with a leaf of bibulous paper.

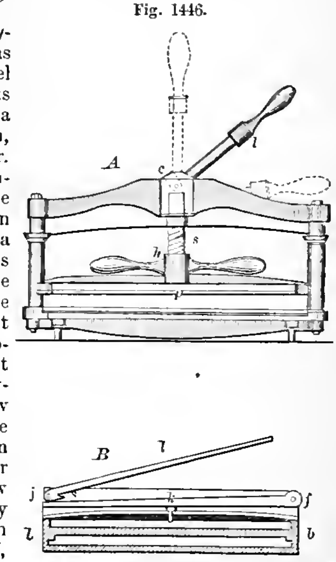
One of the first suggestions in this line was by Benjamin Franklin, who sanded the yet wet ink of the manuscript, passed it between rollers in contact with a polished soft-metal plate, imbedding the emery in the pewter so as to leave an impression from which a copy may be obtained by the copper-plate printing process.

James Watt, about 1780, adopted the plan of pressure of a page of bibulous paper against the damp manuscript, the writing being legible through the thin copying-paper.

Ritchie's copying-press A has formed the model for most of its class, having a bed, a platen, and a cam-lever.

The book containing the manuscript in contact with a damp page, is placed on the bed, and the platen *p* brought down by the rotation of the nut *h*, which traverses the screw *s*. An effective pressure is then brought to bear upon the screw and platen by the oscillation of the lever *l*, whose cam *c*

Fig. 1446.



Copying-Presses.

bears upon the upper end of the screw-shaft, and gives sufficient power to deliver the impression.

BRUNEL'S *copying-press B* acts on the compound-lever principle. The bottom of the press *b* receives the book, and the platen, being laid thereon, is driven down by the pressure of the central stud *k*, which is beneath the lever hinged at *f*.

A second lever *l*, hinged at *j*, and having a cam *s* at the end, is then brought to bear upon the former lever, giving a force equal to the delivery of an impression from the damp ink of the manuscript upon a sheet of thin bibulous paper laid thereon and backed by a damp sheet.

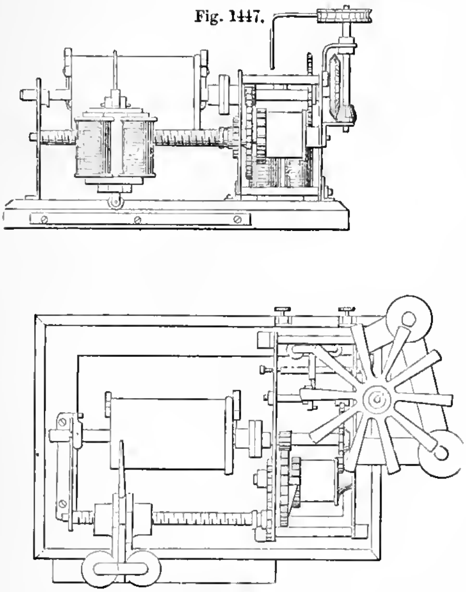
Other modes of copying are found.

The *manifold writer*, invented by Wedgwood, 1806, and consisting of colored sheets alternating with thin paper, and giving a number of identical impressions by the action of a stylus.

Hawkins's polygraph, in which several pencils are carried in a frame, each obeying the action of a principal and writing upon its own particular sheet of paper.

Cop'y-ing-tel'e-graph. An apparatus for automatic telegraphy known as Bonelli's telegraph. The apparatus consists of a dispatching instrument and a receiver at the respective ends of the line.

Fig. 1447.



Copying-Telegraph.

The message is written with a non-conducting ink on a sheet of foil, which is then lapped around the roller, and a sheet of white paper is wrapped on the receiving roller and covered by a sheet of transfer-paper. The electric circuit being established, so long as the point of the lever of the dispatcher is in contact with the metallic surface of the paper, the armature of the receiver is attracted by its magnet, and the stylus of the receiver elevated. When the stylus of the dispatcher crosses the non-conducting ink, the circuit is broken, the stylus of the receiver drops upon the transfer-paper and imprints a mark upon the paper beneath. Bonelli's had five styles and as many wires; the former trailed over the line of letters, making five simultaneous impressions, which gave dotted skeletons of the letters, the points being sufficiently numerous and proximate to enable the letters to be readily distinguished. Instead of the ink of transfer, chemically prepared paper has been used, which was acted upon by the spark, giving visible dots at the points of chemical reaction.

Cor'a-cle. A form of canoe used in Egypt and in Britain from the earliest periods of history. It consists of a light wooden frame covered with hides, and capable of being carried on the shoulders. The coracle is still in use in the West of England, Wales, and in some parts of Ireland.

Fig. 1448.

Coracle.

The same kind of boat is yet used upon the river *Bo-Tchou*, in Thibet, as mentioned by the Abbé Huc, in his "Travels in Tartary and Thibet," 1844–46. "It was composed of ox-hides, solidly sewn together, and kept in shape by some light triangles of bamboo. . . . . The man then took his boat again upon his back, and rode off."

The birch-bark canoe differs mainly from this in the material wherewith it is covered. See CANOE.

Cor'bel. (*Architecture.*) Or *corbeille.* A form of bracket used in Gothic architecture to support the ends of timbers, arches, parapets, floors, cornices, etc. It is a projecting block of stone, usually carved, and with a receding face.

Cor'bel-piece. A bolster, a wooden supporting piece or bracket. A *corbel.*

Cor'bel-ta'ble. A cornice supported by corbels.

Cor-bond'. (*Mining.*) An irregular mass or dropper from the lode.

Cord. 1. A string or small rope composed of several strands twisted together.

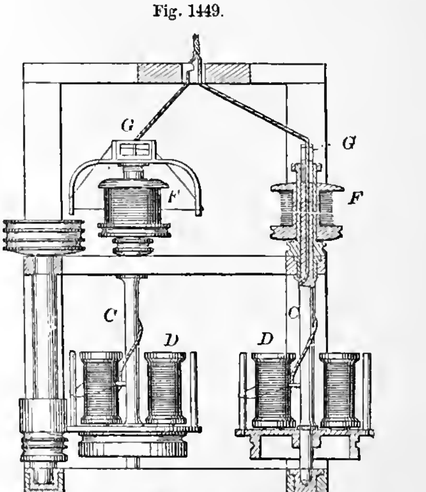
2. A kind of stout ribbed fustian; *corduroy.*

3. In fancy weaving, the space of the design-paper confined by two vertical lines, also the string which connects the *neck-twines* at the *leaf.*

Cord'age. See ROPE.

Cord-cov'er-ing Ma-chine. A machine in

Fig. 1449.



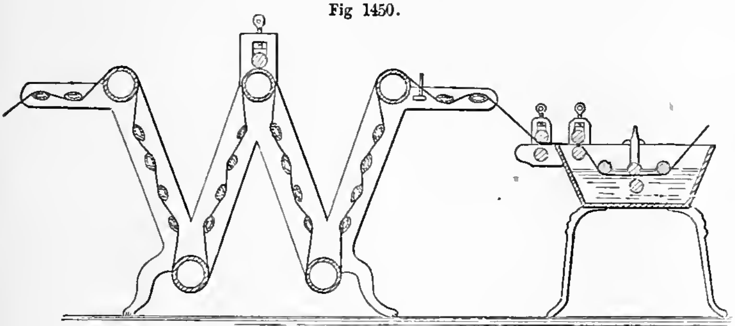
Cord-Covering Machine.

which a cord (or wire) receives a covering of thread or silk; when this is plaited on, it constitutes braiding. (See BRAIDING-MACHINE.) In the machine represented, the yarn-bobbins *D D* are upon carriers, and the yarn proceeds upwardly through the spindles *C* and the flyer-bobbins *F*, which are sleeved thereon and carry the silk, which is twisted by the flyer around the yarn or cord from the spool *D* at a point below where it issues from the guide *G*. At a point above, the three covered yarns are twisted into a threefold cord or bullion.

Cord-dry'er. A machine for drying sized or dyed cords, webbing, tapes, etc.

The stuff passes beneath rollers submerged in the liquid of the tank, thence beneath pressure-rollers, which remove superfluous moisture; then between flattening rollers, thence to the dryer, which has a series of parallel pipes placed in slightly inclined

Fig 1450.



Cord-Drying Machine.

ranges; the material to be dried passing up and down, being interlaced between the pipes. Hollow, heated cylinders, around which the fabric passes, are placed between the ranges.

Cord'ed Fab'ric. One having a pile which is cut in ribs in the direction of the length of the warp, as corduroy.

One having alternate larger and smaller threads, either in the weft or the warp, so as to give a ribbed or corded surface.

Cord'er. (*Sewing-machine.*) A device for laying cords between fabrics, or cords or braids on the surface of a fabric. See "Sewing-Machine Attachments," published by G. W. Gregory, Washington, D. C.

Cor-dil'las. (*Fabric.*) A kind of kersey.

Cord'ing. (*Weaving.*) The *cording of a loom* is the arrangement of the heddles so that they move in such clusters and times as may be required for the production of the pattern. (See DRAFT.) A set of heddles connected with a given shaft is called a *leaf.* Each shaft is connected by a *cord* to the treadle whereby it is moved.

Cor'don. 1. (*Fortification.*) The coping of the revetment of the *scarp*, which is the inner wall of the ditch. At this point the *fraise* is placed, if such be used.

The *cordon* projects a foot beyond the face of the *scarp*, or *revetment.*

2. The edge of a stone on the outside of a building.

Cor'do-van; Cord'wain. A Spanish leather, originally of goat-skin, but now frequently made of split horse-hides. It is finished as a black morocco, and is named from Cordova (the ancient *Corduba*), which is situated on the Guadalquiver, in Andalusia, and was founded by Marcellus. It was the chief emporium of Iberia. The Moorish city contained 300,000 inhabitants in the eighth, ninth, and tenth centuries. It was the great seat of the arts, sciences, and learning in the days of liberal Spain, when the people were worth something, before the black darkness of the Pedros and Philips.

Cor-du-roy'. 1. (*Fabric.*) A stout, ribbed cotton fustian, made with a pile so cut as to leave a surface ridged in the direction of the warp.

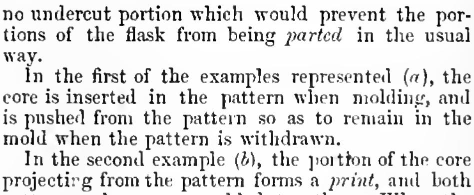
2. A road formed of poles laid transversely and in contact. It is used as a mud-bridge in swampy places.

Core. 1. (*Founding.*) An internal mold which forms the interior of a cylinder, tube, pipe, faucet, or other hollow casting. It is made of various proportions of new sand, loam, and horse-dung. It requires to be thoroughly dried, and when containing horse-dung must be burned to a red heat, to consume the straw. This makes it porous and of a brick-red color.

The core is made in a *core-box*, and has projecting portions, known as *core-prints*, which rest in the *prints* of the mold. The model from which the object is cast is solid, and makes an impression, partly in the cope and partly in the drag. When the pattern is removed, the core is laid in its place, the projecting portions resting in the recesses made by the *prints* of the pattern. Touching the loam of the mold at no other point, it occupies, in the case of a pipe, a central position in the space which is to be run full of metal. When the metal has been poured around it and then cooled, the core is broken out, leaving the casting hollow.

Simple cores are those which do not prevent the *delivery* of the cope and drag, that is, which have

Fig. 1451.



Cores.

no undercut portion which would prevent the portions of the flask from being *parted* in the usual way.

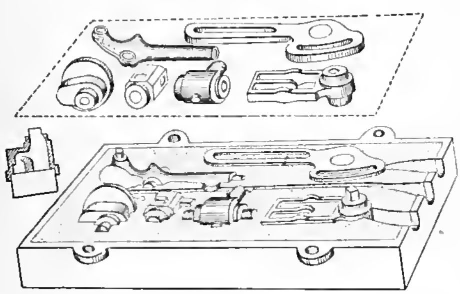
In the first of the examples represented (*a*), the core is inserted in the pattern when molding, and is pushed from the pattern so as to remain in the mold when the pattern is withdrawn.

In the second example (*b*), the portion of the core projecting from the pattern forms a *print*, and both pattern and core are molded together. When the pattern is withdrawn, the core is detached and the *print* inserted in the impression made by it in the cope. That part of the core which was imbedded in the pattern then projects into the space, and the metal is cast around it. The core thus makes a hole *in* the casting, but not *through* it, as will be observed.

In the third example (*e*), the pattern has projecting pieces, called *prints*, on one or both sides; when molded, these projections make holes in the loam. Cores of the required size and shape, and having projections to fit these holes, are previously made, and, being fitted thereinto, are secured thereby, the portions projecting into the open space being surrounded by the metal, so as to make a hole in the casting or a hollow casting, as the case may be, when the core is picked to pieces and broken out of the metal.

The example of patterns and cores shows several arranged in one flask. In one figure, the *ingates* and *runners* are prepared and the cores in their places,

Fig. 1452



Patterns and Cores.

being shaded for distinction. In the upper figure, the articles are in their ultimate shape, with holes in them.

The group includes a stopcock with a cruciform core, which forms the duct and the hole for the spigot. A piece having a straight and a curved mortise, and which delivers its own core. One having only a perpendicular, square core. One with a round core parallel with the face of the flask. One having two rectangular cores crossing each other at right angles. The cap of a double-acting pump, the core for which is shown in section in the small figure; the shaded portions being the metal.

Sheaves are cast with annular cores, the pattern being divided in a plane perpendicular to its axis, which permits one half the pattern to be withdrawn, then the core, then the other part of the pattern. The core is then replaced, and the mold closed.

When a core is made on a large scale, as in the interior mold of a heavy cylinder, cistern, tank, etc., it is called a *nowel*.

2. A central piece occupying an axial position within a circular aperture at which clay or lead exudes in the process of making earthenware or leaden pipes. The core gives the inside shape to the pipe.

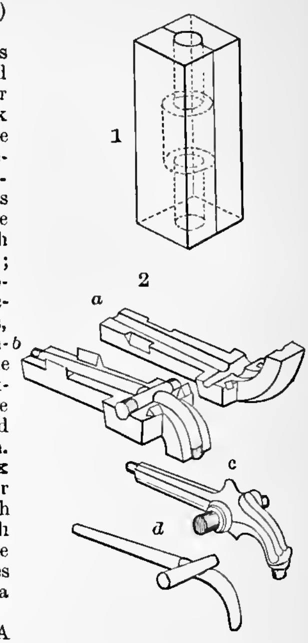
3. (*Rope-making.*) The central strand around which four other strands are twisted in a *shroud hawser-laid* rope.

4. (*Hydraulic Engineering.*) A wall or structure absolutely impervious to water, placed in an embankment or dike to prevent the percolation of water, which may penetrate the porous material of which the remainder of the dike is composed. The core may be of puddle or a wall laid in hydraulic cement.

Core-bar. The bar or spindle which supports the core of a shell.

Core-box. A divisible box in which clay is rammed to form cores. For cylindrical cores, as in the example 1, it divides through the axis, each portion having a recess which is equal to one half of the core to be molded therein. These portions are united by dowel-pins, and held together by clamps while the sand is rammed into them.

Fig. 1453.



Core-Boxes.

The examples (2) represent: —

a b the two halves of a brass or lead *core-box* suitable for casting the stopcock *c*; *d* shows the core itself after its removal from the core-box *b*, in which it is also shown. *c* is the model from which the object is molded; the shaded parts represent the projections or core-prints, which imprint with in the mold the places where the extremities of the core *d* are supported when placed therein.

Core-box Plane. A peculiar form of plane which has a cutting tooth projecting below the sole, to plow grooves in the parts of a core-box.

Core-print. A projecting piece on a pattern for molding, to form a hole in the mold to receive the end of the core by which it is sustained in the mold in proper position relatively to the object cast. (See *e*, Fig. 1453.)

Cor′er and Sli′cer. An implement for cutting the core out of a peeled apple, and at the same time cutting into pieces for cooking or drying. (See Fig. 281.)

Core-valve. A plug-valve which has a rotary reciprocation in a cylindrical or hollow conical seat; occupying about the same relative position to its seat as the core of a faucet does to the casting itself.

Co-rec′tome. *Coretome.* An instrument for cutting through the iris to form an artificial pupil. An *iridectome* (which see).

Corf. (*Mining.*) 1. A basket to carry coal or ore. A *corve*.

2. A square frame of wood to carry coals on.

3. A sled or low-wheeled wagon in a mine, to convey coal or ore from the miners to the bottom of the shaft.

Cork. The bark of the evergreen oak (*Quercus suber*). It grows in the South of France, in Tuscany, Spain, Portugal, and Algeria. The tree sheds its abundant bark naturally, but this produce is valueless commercially.

The cork-tree at the age of twenty-five years is barked for the first time. A circular incision is first made through the bark near the ground, and another, also around the tree, close by the branches. These cuts are followed by others equally deep, made longitudinally, and dividing the bark into broad planks. The tree is then left: the sap has been stopped from circulation; the bark begins to dry and curl outward; and shortly each strip is peeled off by the hand. This process is repeated every ten years. Thus gathered, this bark is prepared for market in two ways. By one method, the *tables*, as they are called, are heaped one upon another, their concave sides being undermost, in deep trenches, and, being plentifully moistened, are pressed beneath huge bowlders till thoroughly flattened out. They are then dried carefully before large fires, and turned constantly. When perfectly flat and dry, they are complete.

By the second method the damp pressure in the pits is dispensed with, the *tables* being simply laid with their convex sides toward the fire, and suffered to remain until their warp is lost and they become flat. This tree and its uses were known to the Greeks and Romans. In the time of Pliny it was employed for nearly as many purposes as at present; as floats for fishermen's nets, waterproof soles for shoes, buoys for anchors, and for swimming-jackets. The use of cork for stopping bottles was not entirely unknown to the Romans, being mentioned by Cato and Horace, though its application to this purpose does not seem to have been very common, as we find everywhere directions given to close up wine-casks and other vessels with pitch, clay, gypsum, or potter's earth, or to fill the upper part of the vessel with oil or honey, in order to exclude the air from those liquors which they wished to preserve.

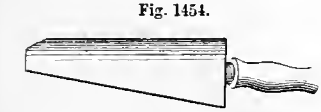
Stoppers of cork seem to have been first introduced after the invention of glass bottles, and these do not appear to have come into use before the fifteenth century. When Stephanus wrote (in 1553), cork was used in France principally for soles; and in Germany wax stoppers were used by the apothecaries until about the close of the seventeenth century,

Where the tree is indigenous, the inhabitants apply cork to many purposes. In Spain, beehives and kitchen pails, pillows and window lights; in Morocco, drinking-vessels and plates, tubs and house-conduits; in Portugal, roofs for houses, lining for garden-walls, and fences for poultry-yards; in Turkey, cabins for the cork-cutters and coffins for the dead; in Italy, images and crosses, pavements along the *via crucia*, and buttresses for the village churches; in Algeria, shoes and wearing-apparel, saddles and horseshoes, armor and boats, landmarks and fortifications, furniture in mansions, racks in stables, and steps for houses. Its use for floats, shoe-soles, wads for howitzers, bungs, stoppers, hat foundations, life-boats, models of architecture, and as a material for Spanish black, are familiar to most of us.

Cork-clasp. A wire attached to the neck of a bottle, and holding down the cork. See BOTTLE-STOPPER.

Cork-cut'ter's Knife. The knife of the cork-cutter has a very thin and sharp blade about six inches long and tapering, with a truncated end. It is constantly whetted upon the board from which rises the stake on which the cork rests during cutting.

Fig. 1454.



Cork-Cutter's Knife.

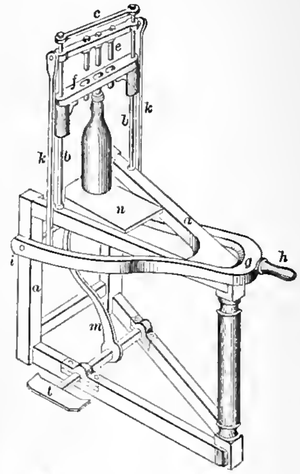
Cork-fau'cet. One adapted to be inserted through a cork, to draw the contents of a bottle. See BOTTLE-FAUCET.

Cork'ing-ma-chine'. One for driving corks into bottles. *a* is the frame; *b b*, two vertical guide-rods connected at top by the bridging-piece *c*. A cross-head sliding on the upper ends of the guide-rods *b b* is connected by side-rods *k k* to the lever *g*, the branches of which have their fulcrums at *i*, and are united at the handle *h*. In the cross-head are secured three metallic plugs *e*, immediately above the holes in the cross-piece *f*, which is firmly secured to the guide-rods *b*. In the cross-piece *f* are three conical tubes of different sizes, so as to suit the varying necks of bottles of different sizes. The upper ends of the tubes are larger than the lower ends, through which the corks are forcibly driven. *n* is a wedge-shaped piece whose upper surface is horizontal, and it is moved to and fro in slides by means of the treadle *t* and arm *m*.

The operation is as follows: —

The workman seats himself at the machine, one foot on the treadle, and the handle *h* in his right hand. He places a bottle on the wedge *n*, with its neck beneath such one of the three tubes as will contain a cork of the size he sees to be suitable. Such a cork being placed in the tube, a motion of the treadle raises the bottle, and the depression of the lever *h g* drives the cork into the neck of the bottle. The reverse motions of the lever and treadle release the bottle. See BOTTLING-MACHINE.

Fig. 1455.



Masterman's Corking-Machine.

Father Penguin, a monk of the monastery of Hautvilliers (died in 1715), seems to have been the inventor of sparkling champagne. The wine of the country had been celebrated for centuries, but the old Benedictine discovered the art of making it effervescent, and secured it by a *cork* and *string*.

Cork-fast'en-er. See BOTTLE-STOPPER.

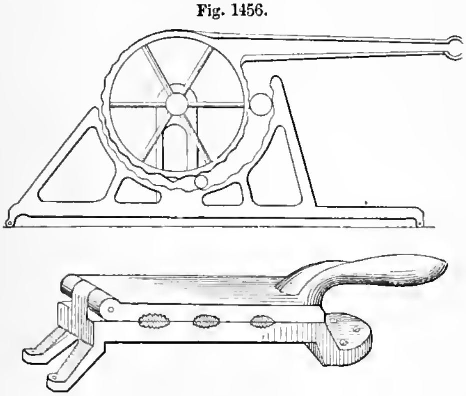
Cork-jack'et. A jacket lined with cork for the purpose of sustaining the wearer on the surface of the water. The Roman whom Camillus sent to the capitol when besieged by the Gauls is reported to have supported himself by a cork-jacket as he swam the Tiber with his clothes on his head.

Cork-ma-chine'. Corks are made by hand and by machinery. The former readily but slowly produces the perfectly shaped, somewhat tapering cork; the latter process produced a cleanly cut cork, usually of cylindrical form, the tapering form being afterwards given by pressure. In hand-making, the workman, with a sharp knife in his hand, and a block of cork in his left, forms the cork by two semicircular cuts. In the machine, the knife cuts a perfect arc; the machine drops the cork into one receptacle and the shavings into another, and the hone instantly sharpens the knife for farther work.

In another form of machine, the slabs are cut into square blocks by a circular knife mounted like a circular saw. The square pieces are then held by the hands of boys in a kind of lathe, in such a position that the sharp and thin end of a hollow cylindrical cutter will cut out a perfectly round cork in an instant. Cutters of various sizes are employed to cut corks of the desired size. Each cork is then placed by little fingers in corresponding recesses, in a feed-wheel of an automatic machine, where the corks are tapered by the removal of a thin shaving from the periphery of one end. The shaving is removed by the sharp edge of a circular cutter over two feet in diameter, which revolves horizontally. The edge of every instrument that cuts cork is brought in contact with the material to be cut with a very *drawing* stroke, as such spongy material could not be cut satisfactorily by a *crushing* stroke. Thick slabs of cork are cut into large corks, while the thin ones are worked into corks of a corresponding size.

Cork-press. One in which a cork, previously wetted, is rendered elastic, to enable it the more readily to enter the neck of a bottle. In one form,

Fig. 1456.



Cork-Presses.

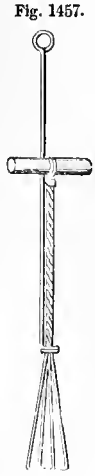
the cork is placed between the serrated surfaces of the concave and the eccentric cam, and pressed to a less or greater extent by a partial rotation of the latter.

Another form is a lever press with jaws.

Cork-pull. A substitute for a corkscrew, having hooks or fangs which clasp a cork when in the bottle and draw it thence.

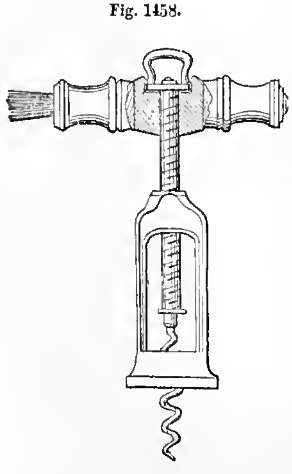
The jaws, while collapsed by the slide, are passed through the neck of the bottle ; and, being opened, are then clasped around the cork by the motion of the slide, and the cork with its retractor is drawn from the bottle.

Fig. 1457.



Cork-Pull.

Fig. 1458.



Corkscrew.

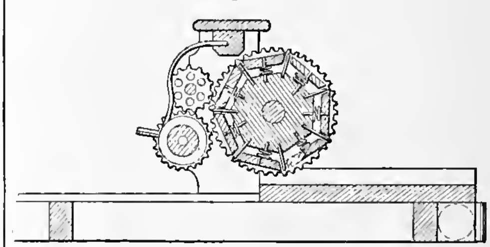
Cork'screw. The double-screw which entered the cork by rotation, and then withdrew it by a continued or reversed circular motion, was patented in England by Thomason, 1802.

Cork'screw-stair'case. A winding stairs with a solid newel.

Cor'liss-en'gine. A form of steam-engine having a variable and automatic cut-off of peculiar character. (See CUT-OFF.) It has two inlet and two exhaust valves, which are segmental, and vibrate, each on its spindle, within a bored cylindrical seat. The valves are independently moved by rods from a vibrating disk, which is operated by an eccentric and rod. The mechanism which opens the valve is thrown out of gear during every stroke of the engine. When this disconnection takes place, the valve is instantaneously closed by a spring, which is cushioned by a small piston closing on compressed air. The instant at which the steam-valves are thrown out of gear, and the steam thus cut off, depends on the position of the balls of the governor at the moment. The exhaust-valves open invariably to their full extent. See CUT-OFF.

Corn-cake Cut'ter. A stamp or form which cuts corn-cakes from the sheet of dough ; or a ma-

Fig. 1459.



Cake-Cutter.

chine having a roller carrying said forms and cutting into shapes the sheet of dough, which is spread upon the table passing beneath.

Corn-cov'er-er. A plow or pair of plows to run alongside a row of dropped corn and throw earth upon the seed. Sometimes followed by a roller on the same stock to compact the earth.

Corn-crib. A granary for corn, having openings between the slats forming the sides, to enable the crib to admit air and season the corn without molding.

Corn-cul'ti-va'tor. A plow for cultivating corn in hills or drills. See CULTIVATOR.

Corn-cut'ter. 1. (*Agriculture.*) A knife or a machine for cutting corn. See CORN-KNIFE ; CORN-HARVESTER.

2. (*Surgical.*) An instrument for removing horny excrescences from the feet.

Corn-drill. A planter for sowing corn in rows.

The corn-planter, properly speaking, places the seed in hills in a row. When the rows are *checked*, so called, the corn may be worked one way and then across, and so on. Corn in drills can be tended but one way. See CORN-PLANTER.

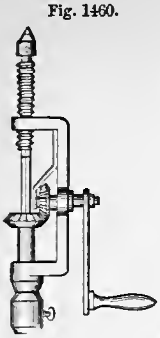
Cor'ner. (*Book-binding.*) *a.* Leather corner-covering to a half-bound book.

b. A triangular tool used in gold or blind tooling.

Cor'ner-chis'el. A chisel with two edges projecting rectangularly from a corner ; used for cutting the corners of mortises.

Cor'ner-drill. One driven by a crank and bevel gearing, being thus adapted to bore in places where

Fig. 1460.



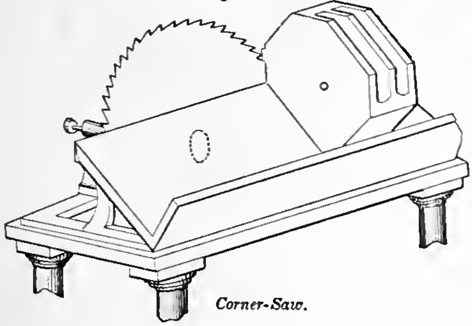
Corner-Drill.

the surrounding frame or machinery will not allow the revolution of the ordinary brace-handle. The back-center has a rigid support, and the tool is advanced by the occasional rotation of the feed-screw, by a lever-pin in the transverse hole of the screw-head. Also called a *French drill.*

Cor′ner-punch. (*Machinery.*) An angular punch for cleaning out corners.

Cor′ner-saw. One for removing the corners of a block, giving it an octagonal shape. The saw-mandrel is mounted in a head which traverses on ways parallel to the trough in which the block is placed. The block is slid in the trough, bringing it against the saw, and taking off the corners in

Fig. 1461.



Corner-Saw.

succession. It is one of the series of block-making machines.

Cor′net. 1. (*Music.*) *a.* A wooden wind-instrument of the oboe class, long since disused.

b. A metallic wind-instrument resembling a trumpet, and used in bands. The *cornu* of the Romans, like the instruments mentioned in Leviticus (xxv. 9), was curved and formed from a horn. It was afterwards of metal, probably copper. Its invention is credited by Athenæus to the Etruscans. It differed from the *tibia* in being larger, and from the *tuba* in being curved. It had no keys or stopples.

2. An auricular instrument which does not protrude beyond the external ear. It is used in cases of obstruction of the *meatus auditorius*, by reason of contraction, or the presence of polipi, and is made of gold or silver.

Cor′net-a-Pis′tons. (*Music.*) A metallic wind-instrument of the trumpet class, furnished with valves and stoppers. These instruments, under the care of Sax of Paris and Distin of London, have attained great excellence.

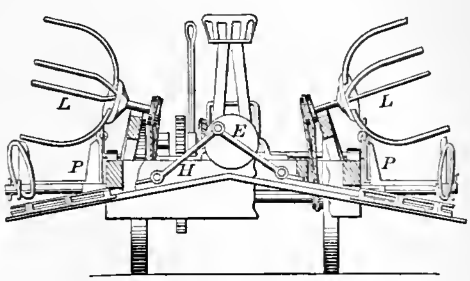
They are made of various sizes and compass, so as to embrace different parts.

Corn-grat′er. A roughened surface for rasping green corn from the cob.

Corn-harp. A Scottish agricultural implement, of the nature of a sieve, for freeing grain from the seeds of weeds.

Corn-har′vest-er. A machine for cutting corn in the field; sometimes delivering the corn in

Fig. 1462.

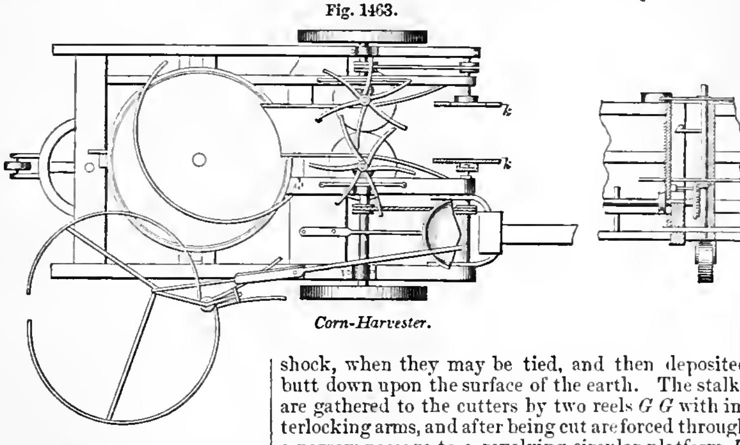


Corn-Harvester.

shocks, sometimes merely laying it in gavels upon the ground, or in a cradle on the machine, from whence it is taken by hand and shocked. Fig. 1462 shows a corn-harvester for cutting two rows at a time. The reels *L* are set obliquely, so as to gather the corn to the knives and tilt it over so that it drops into the boxes *P*, which, as soon as a sufficient amount has been thus collected, are tilted up, to discharge the gavel in a heap upon the ground. The sickle-knives are driven by the wrist-wheel *E* and pitmans *H*, by power derived through gearing from the main axle.

Fig. 1463 is a machine for cutting a single row, keeping the stalks vertical, collecting them into a

Fig. 1463.



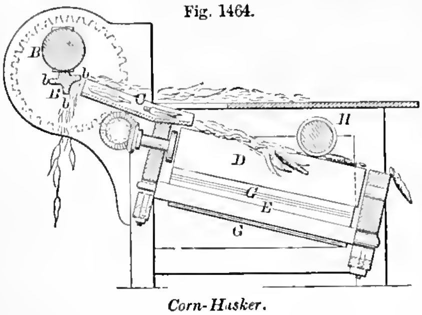
Corn-Harvester.

shock, when they may be tied, and then deposited butt down upon the surface of the earth. The stalks are gathered to the cutters by two reels *G G* with interlocking arms, and after being cut are forced through a narrow passage to a revolving circular platform *H* surrounded by hoops, so arranged that one half may be opened outward for the discharge of the shock; the stalks are held upright in this receptacle by a semicircular spring upon the top of the hoops. To a post upon the main frame is pivoted a lever, which operates a clasping device by which the shock is lifted for discharge. Two small reels *k k* at the front of the frame, revolving in perpendicular planes, pick up broken stalks.

Corn-hull′er. A machine for removing the hull or cuticle from grains of corn, without powdering the same. See HOMINY-MACHINE.

Corn-husk'er. A machine for taking the ear of corn out of its enveloping sheath of leaves. Some

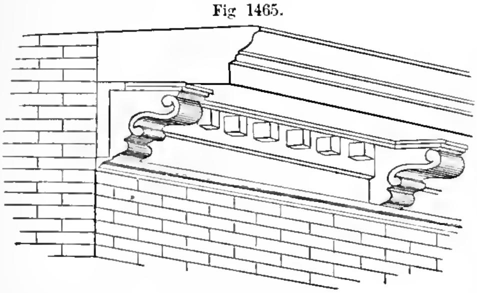
Fig. 1464.



Corn-Husker.

machines operate upon the corn in the field to husk it off the stalk; in others, the ear is simply jerked from the stalk, and the machine tears off the husks from the ears. Fig. 1464 shows one in which shocked corn is husked. The unhusked corn in the stalk is laid upon the table at the top of the machine, and pushed, butt-ends forward, between two feed-rollers *B B*, whereupon the ears are separated from the stalks by cutters *b*, arranged longitudinally upon the lowermost of the feed-rollers. The severed

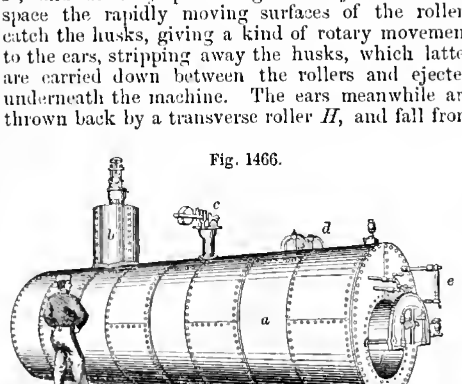
Fig 1465.



House-Cornice.

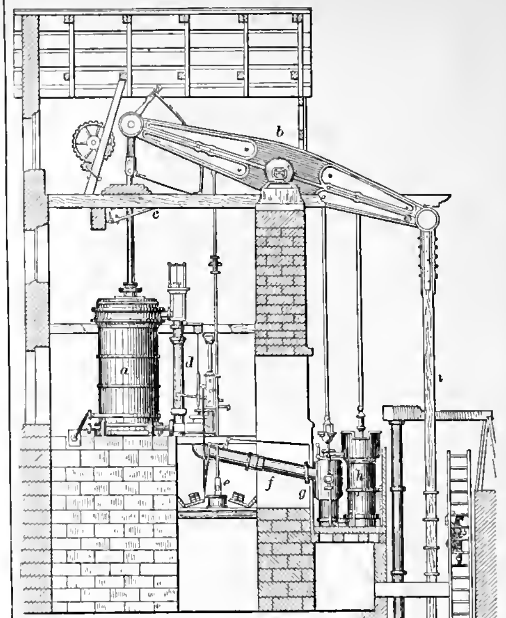
ears pass down upon an inclined plane *C*, which directs them into the trough-like space between the two individual rollers of each pair of husking-rollers *D*, and as they pass longitudinally down such space the rapidly moving surfaces of the rollers catch the husks, giving a kind of rotary movement to the ears, stripping away the husks, which latter are carried down between the rollers and ejected underneath the machine. The ears meanwhile are thrown back by a transverse roller *H*, and fall from

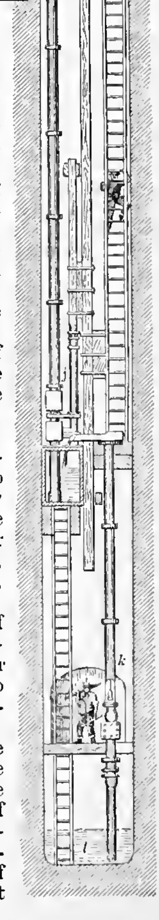
Fig. 1466.



Cornish Boiler.

Fig. 1467.





Cornish-Engine.

the rear. *E* is a smaller lower roller, and *G* an endless apron which leads away the silk and husks.

Corn-husk Split'ter. A machine to tear husks into long shreds for stuffing for mattresses, etc.

Cor'nice. A projecting molding consisting of several members, which crowns or finishes an entablature, the top of a building, a door, window, pedestal, or pier. A *cornice* on a pedestal is called a *cap*.

Cor'nice-plane. An *ogee* plane for working moldings.

Corn'ing. 1. The process of granulating gunpowder. The place where it is done is known as the *corning*-house.

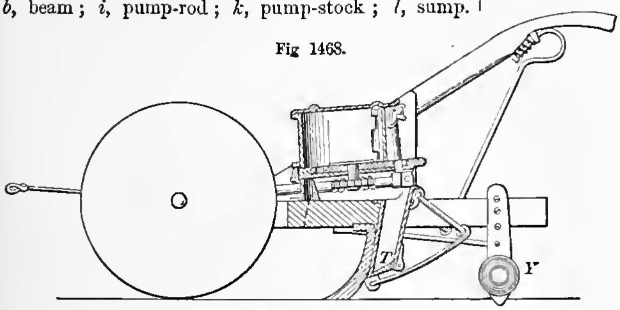
2. The process of curing meat.

Cor'nish-boil'er. The cylindrical-flue boiler of Smeaton, who did so much to increase the economy of working steam. The cut shows the modern form with the throttle over the steam-dome *b*; the safety-valve *c*, invented by Papin; the man-hole *d*, gage-cocks, steam-gage *e*, etc.

Corn'ish-en'gine. A form of single-acting condensing steam-engine used especially in the copper and tin mines of Cornwall, but also used as a pumping-engine for water-supply in very many places.

Steam, being admitted above the piston at the commencement of the stroke, follows the piston to the point of cut-off; the remainder of the stroke is completed by the combined aid of expansion and the momentum acquired by the mass of material set in motion by the first impulse of the steam. On the completion of the stroke, the steam is allowed to pass freely from one side of the piston to the other, producing an equilibrium of effect during the out-stroke. Before the piston arrives at the point of commencement again, the equilibrium-valve is closed, shutting in a quantity of steam before it. By means of this cushioning, which is subject to the nicest adjustment, the loss from clearance and steam-ports is rendered practically nothing, if the steam so compressed be equal to the initial pressure. The piston is thus gradually brought to a neutral state at the end of the stroke, when the exhaust-valve opens a communication by pipe *f* between the lower end of the cylinder *a* and the condenser *g*. *c* is the cataract; *b*, beam; *i*, pump-rod; *k*, pump-stock; *l*, sump.

Fig 1468.



Walking-Planter.

The great care and systematic mode of reporting the duty of the engines of Cornwall has enabled a more careful review to be made in respect to the gradual improvement of the steam-engine than has been afforded by any other description of engine. See DUTY.

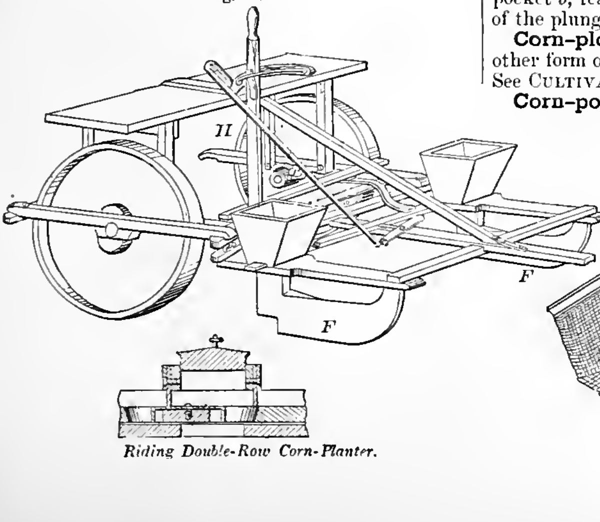
Corn-knife. A blade about twenty inches long, attached by a tang to a handle, and used for cutting standing corn. It resembles the cane-knife or machete, and is used for a similar purpose.

Corn-mill. A farm or plantation mill, usually of iron both as to its runner and the concave, and used for rough-grinding corn on the cob for stock.

Cor-no'pe-an. (*Music.*) A kind of cornet with valves.

Corn-plant'er. A machine for dropping corn in hills, previously opening the ground for the reception of the seed, and subsequently throwing back the earth and rolling it flat.

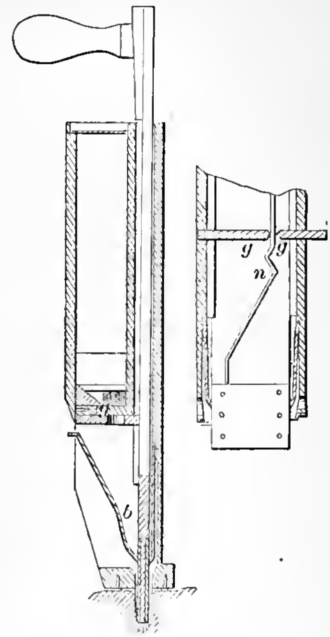
Fig. 1469.



Riding Double-Row Corn-Planter.

Fig. 1468 shows a corn-planter used like a plow; a man follows and operates the seed-valve *T* by a hand-trigger. A rotating pocketed disk in the adjustable hopper is rotated at varying speeds by a worm on the shaft rotated by a pinion engaging with one or another of the gear-wheels on the main shaft. The share opens the furrow, the roller *Y* covers the seed.

Fig. 1470.



Hand-Planter.

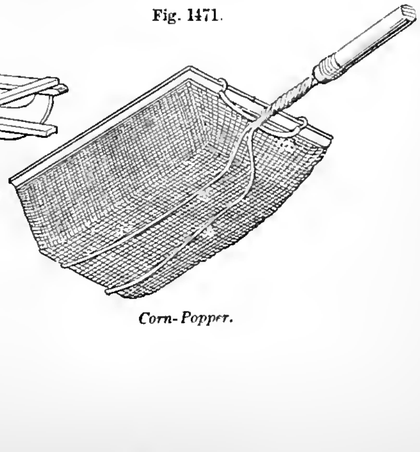
Fig. 1469 is arranged to plant two rows at once, the operator riding on the machine and working the seed-slides by a lever, or allowing them to be worked by a cam driven by the axle, as may be desired. The sled-runners *F F* open the furrow; by a motion of the upright lever *H* the planting part may be lifted clear of the ground, resting on the tongue and wheels in going from field to field or turning at the ends of the rows.

Another form is a hand-planter, which is thrust into the ground. The downward motion of the plunger drives the seed into the ground. The upward motion operates the seed-slide *g g* by the zigzag *n*, and deposits another bunch of grains in the pocket *b*, ready to be thrust out by the next descent of the plunger.

Corn-plow. A shovel-plow, double-shovel, or other form of plow for tending crops planted in hills. See CULTIVATOR.

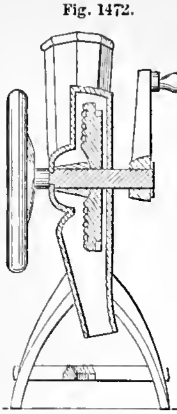
Corn-pop'per. A wire basket in which pop-

Fig. 1471.



Corn-Popper.

Fig. 1472.



Disk-Sheller.

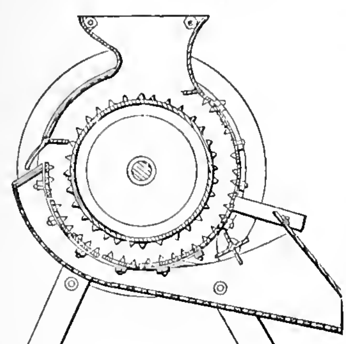
corn is heated till the hull cracks open and allows the starchy follicles to expand.

Corn-row Mark'er. A sled with a gaged width between the runners for marking out rows in which to plant corn. It has an outrigger, which scratches the ground at another gaged distance, as a guide for the next trip. The process is repeated at right angles to the former markings, and the intersections of the marks are the places for dropping the seed.

Corn-shell'er. The *corn-sheller*, for rubbing the grains from the cob, is made in various forms.

1. The roughened or toothed disk (Fig. 1472), which operates upon the ears in connection with a chute or oblique pressure-board, which holds

Fig. 1473.

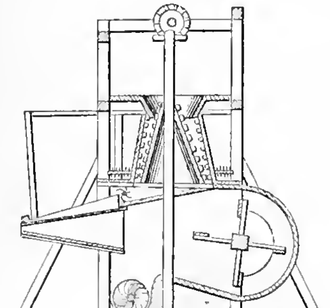


Cylinder-Sheller.

the corn against the rubber.

2. The cylinder (Figs. 1473 and 1474) with toothed periphery acting upon the ears in connection with a concave, which affords a gradually decreasing throat as the ears roll and rub and part with their grains.

Fig 1474.



Cone-Sheller.

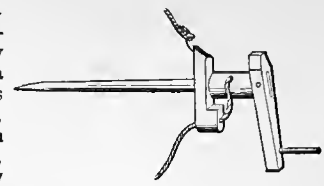
3. An orifice into which the ear is driven by a blow from a mallet, driving the cob through and shelling off the grains.

Corn-shock Ty'er. An implement for straining a band around a shock of corn, to facilitate tying. The pin is thrust into the shock, and one end of the band fastened to one part, while the other end of the band is wound upon the axis.

Corn-shock'ing Ma-chine'. A machine for cutting corn in the field and binding it into shocks.

Corn-stalk Cut'ter. A machine for gathering the dry corn-stalks of a previous year's crop into rows, and cutting them into short pieces, so that they may be covered in by the plow.

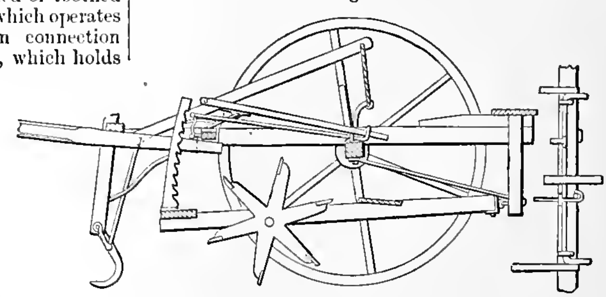
Fig. 1475.



Corn-Shock Tyer.

The hooks, attached to hanging-posts, are in the advance, and are maintained in position by certain devices. Their duty is to straighten out the corn-stalks parallel with the line of motion of the machine. The rotating cutter-wheel has its bearings in a vertically adjustable frame.

Fig. 1476.

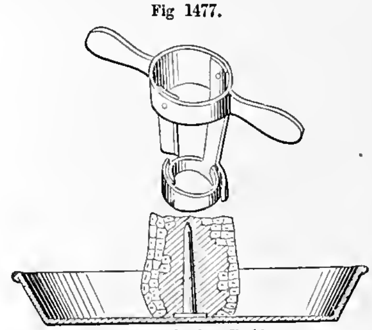


Corn-Stalk Cutter.

Corn-strip'ping Knife. A knife for cutting green corn from the cob for cooking or canning.

The roasting ear is erected upon a spike in the

Fig 1477.



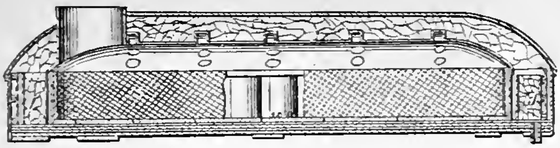
Corn-Stripping Knife.

dish; the corn is stripped from the cob by a handled cutter with curved, lapping spring blades.

Co-ro'na. (*Architecture.*) A broad, projecting face forming the principal member of a cornice. The soffit is *throated*, so as to form a drip edge.

Corpse-cool'er. A temporary coffin or shell in which a corpse is laid to delay the natural decay by exposure to an artificially cooled atmosphere. In Fig. 1478, the metallic case has an interior wire basket to receive the corpse. Between the basket and case are pipes which contain a freezing mixture. The cover has hollow pockets for the circulation of air, which passes into the pans to which the tubes are attached. The inner cover is cooled with ice, and the outer one incloses the interior arrangements.

Fig. 1478.



Corpse-Preserver.

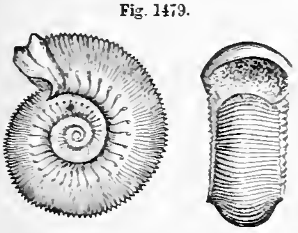
Cor'ri-dor. 1. (*Fortification.*) The covered way forming a walk around the whole of the work.

2. (*Architecture.*) A gallery or open communication to the different apartments of a house.

Cor'ru-gat'ed I'ron. Sheet-metal pressed into wrinkles or folds, so as to give it greater stiffness. It is used in many ways; as sheathing, house-covering, roofing, etc.

"As admirably shown by Buckland, the partitions which separate into chambers all the whorls of the ammonite except the outermost one were exquisitely adapted to strengthen, by the tortuous windings of their outer edges, a shell which had to combine great lightness with great powers of resistance. Itself a continuous arch throughout, it was supported by a series of continuous arches inside, somewhat resembling in form the groined ribs of the Gothic roof, but which, unlike the ponderous stone-work of the medieval architects, were as light as they were strong. And to this combination of arches there was added, in the ribs and grooves of the shell, yet another element of strength, — that which has of late been introduced into iron roofs, which, by means of their corrugations, — ribs and grooves like those of the ammonite, — are made to span over wide spaces without the support of beams or rafters. Still more recently, the same principle has been introduced into metallic boats, which, when corrugated, like the old ammonites, are found to be sufficiently strong to resist almost any degree of pressure without the wonted addition of an interior framework." — HUGH MILLER.

Fig. 1479.

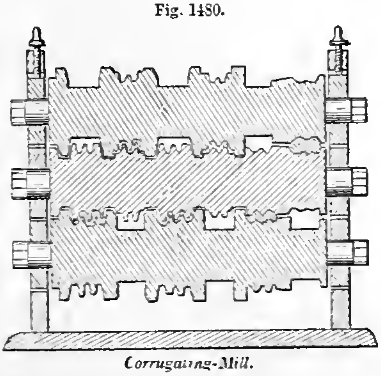


Ammonites humpriesianus (*Oolite*).

Cor'ru-gat'ing-ma-chine'. A machine for corrugating sheet-metal.

In one form it is a rolling-mill in which a series of parallel grooves, alternating with parallel elevations, is cut in the circumference of the central roll, and counterpart grooves and elevations are formed in the upper and lower roll, so that the iron is passed consecutively between the rolls in opposite directions; in another form the rolls are grooved longitudinally. In another form the corrugation is by simple pressure between dies.

Fig. 1480.



Corrugating-Mill.

Co-run'dum. A hard mineral consisting of crystalline alumina. The sapphire and ruby are allied substances of different colors. Emery is a dark-colored, granular variety. See EMERY.

Corundum is used in powder of varying fineness; is made up into wheels and laps with gums, resins, glue, etc.; is used by dentists in the form of cones, cups, files (round, taper, and oval), slabs, wheels, laps, bobs, points, tape.

It is made into various grades by pounding and sifting. Is molded in forms and presses.

Cor-vette'. (*Nautical.*) A ship-rigged man-of-war with a flush deck, and carrying from eighteen to twenty-six guns, in one tier. It ranks next below a *frigate*.

Cor'set-mak'ing Ma-chine'. A loom for weaving fabrics having an undulating contour of varying dimensions. It is arranged to make the tubular spaces for the introduction of the whalebones. In the machine exhibited at the French Exposition in 1867, the principle of a constant length of travel for the shuttle was adopted for the sake of simplicity; but as it is necessary, in weaving the gores, that the weft-thread should pass through only a part of the breadth of the warp, the Jacquard has been employed for the purpose of taking up the portion of the warp required to be woven in that part. As the shuttle always passes over the full breadth of the warp, of which only one portion, say one third, is to be used, it unwinds the full length of weft thread from the bobbin, but only one third of it is tied in the warp. In repassing the shuttle one third more is tied, thus leaving one third of the unemployed weft-thread in the form of a loop upon the article manufactured. To remove this superfluous thread, the thread-catcher, which is a lever with an elastic finger, passes from behind, through the lay on each side of the reed, and pulls the thread out. The shuttle is conveyed by a carrier to the center of the warp, where it is taken by the other carrier and passed through the remainder of its course.

The most difficult part of the work is performed by the *regulator* or *take-up motion*, the action of which is to take up the woven cloth in such a manner as to leave a straight line in front of the reed. As the cloth is woven first only on one side; then for the whalebone pockets, where the cloth is double, evenly over the full breadth; thirdly, on the other side only; and, finally, for the full breadth at the back and front of the stay, — the motion of the regulator must change accordingly. To effect this, the cloth passes between two sets of rollers, the upper of which are simple pressure-rollers, to be regulated by springs and set screws. The lower rollers are fluted and worked by a system of levers independent of each other. The levers are worked conjointly by the Jacquard and lay, so that the lay gives only a movement to those levers which have been previously acted upon by the Jacquard.

An elastic-warp tension is obtained by a peculiarly constructed lever combined with an elastic brake, so as to render the whole machine fit for flat, convex, plain, or richly ornamented work, according to the cards placed upon the Jacquard, and the material put in warp and shuttle.

Cos'aques. French fancy paper for wrapping sweetmeats.

Cos'mo-labe. An astronomical instrument resembling the astrolabe, and formerly used for measuring angles.

Cos'mo-ra'ma. A pictorial exhibition in which the views are laid horizontally upon a semicircular table, and reflected by diagonal mirrors to the lenses at which the eye of the spectator is successively applied. The pictures are illuminated by hidden lamps.

Cos'mo-sphere'. An apparatus for exhibiting the relation of the earth to the fixed stars. A terrestrial globe is placed in the center of a large, hollow glass sphere on which are depicted the stars and constellations.

Cos'sas. (*Fabric.*) A kind of plain India muslin.

Cos'tean-ing. (*Mining.*) A Cornish term for a method of prospecting for metallic lodes. Trenches or pits are dug in the superficial strata, and united by a drift which crosses the direction of the vein, if any exist; the veins in the vicinity affording a guide for direction. *Costeening.*

Cot. 1. A sort of refuse wool.

2. A sheath or sleeve; as a clothing for a drawing-roller of a spinning-frame; a cover for a sore finger.

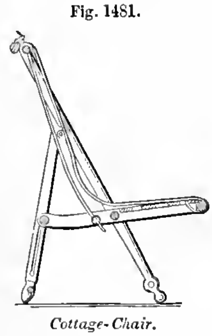
3. A rude boat, as a dug-out or canoe.

4. A bedstead.

Co-til'lion. (*Fabric.*) A woolen material in black and white for ladies' skirts.

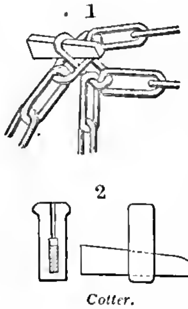
Cot'tage-chair. A form of chair adapted for comfort rather than show, and capable of being carried on to the lawn, on picnics, etc. A *folding* chair.

Fig. 1481.



Cottage-Chair.

Fig. 1482.



Cotter.

Cot'ter. A key. A wedge-shaped piece driven between the gibs in attaching a strap-head to a connecting-rod and tightening the brasses of a bearing. See KEY.

1. A key inserted into a link which has been passed through another link of a chain. A broken chain is thus temporarily mended. This mode is adopted in fastening a log on the sled, and generally in securing an object by a chain when the whole length of the latter is not required. The hook at the end of the chain usually forms the *cotter*, and it is much better than making a running noose of the chain in the link, as the latter is difficult to unfasten, while the cotter can be slipped or driven out, leaving all free. A *toggle*.

2. A wedge which is driven alongside the end of the tongue in the mortise of the sled-roller, tightening the latter against the *gib*. See GIB.

The cotter used for temporarily holding an iron plate to the rib of a vessel while being riveted is shown at 2, Fig. 1482. The cotter has a slight spring, and the taper pin has a wedging action upon the plate.

Cot'ter-drill. A drill for boring slots; it or the work having a lateral motion after its depth is attained.

Cot'ter-file. A narrow file with straight sides, used in filing grooves for cotters, keys, or wedges.

Cot'ter-plates. (*Founding.*) The flanges or lips of a mold-box.

Cot'ton. A plant, or the fibrous product thereof, having a scientific Latin name (*gossypium*), but an Arabic common name (*goton*), which pleasantly reminds us of the great people from whom we derived it.

Herodotus (Book III. c. 106) refers to the cotton of India: "The wild trees of that country bear fleeces as their fruit, surpassing those of the sheep in beauty and excellence; and the Indians use cloth made from this tree-wool." In another place he states that the Indian contingent of the army of Xerxes wore cotton drawers (Book VII., German *Baumwolle*, tree-wool, c. 65).

Theophrastus, the disciple of Aristotle, derived farther information from the expedition of Alexander, and says: —

"The trees from which the Indians make clothes have a leaf like that of the black mulberry, but the whole plant resembles the dog-rose. They set them in the plains arranged in rows, so as to resemble vines at a distance. They bear no fruit, but the capsule containing the wool is, when closed, about the size of a quince, and when ripe it expands so as to emit the wool, which is woven into cloths, either cheap or of great value."

Aristobulus, one of Alexander's generals, mentions the cotton-plant as the "wool-bearing tree," and stated that its capsules contained seeds, which were taken out, and that what remained was combed like wool. Nearchus, Alexander's famous navigator, also refers to it, and says that the shirts, mantles, and turbans of the people of India were made of it. Strabo, on the authority of Nearchus, refers to the fabrics of cotton as being flowered and beautifully dyed.

An awning of cotton was spread over the theater by Lentulus Spinther, July 6, 63 B. C. Linen had been formerly used.

Pliny mentions cotton in four places in his Natural History; two refer to the account of Theophrastus, one to the *carbasa* (cotton) of Spain, one to the cotton of Egypt: —

"In Upper Egypt, towards Arabia, there grows a shrub, which some call *gossypium*, and others *xylon*, from which the stuffs are made that we call *xylina*. It is small, and bears a fruit resembling the filbert, within which is a downy wool which is spun into thread. There is nothing to be preferred to these stuffs for softness and whiteness; beautiful garments are made from them for the priests of Egypt."

The old hatred of the Egyptian priests for wool and preference for flax would not militate against the cotton when they found it to be vegetable growth. In the earlier periods of the Nile people, nothing but linen was used by priests or for embalming.

Arrian the historian (d. A. D. 140) cites the importations from the East to Europe of cotton goods, plain and ornamented. The muslins of Bengal were then called *Gangitiki*, to indicate that they came from the Ganges. The Indian names yet survive in the words *muslin*, named from Moussol, and *calico* from Calicut.

Julius Pollux, in the Onomasticon (A. D. 170), refers to the cotton of India, which he terms *byssus*, and compares with flax: —

"The tree produces a fruit most nearly resembling a walnut, but three-cleft. After the outer covering, which is like a walnut, is divided and dry, the substance resembling wool is extracted, and is used in the manufacture of cloth for woof, the warp being linen."

Cotton paper used by the gold-beater is mentioned by Theophilus Presbyter about A. D. 800.

On the discovery of America by Columbus, cotton formed the principal article of clothing among the Mexicans. They interwove it with fine-spun hair of rabbits, or with feathers for state robes. The cuirasses of thick cotton fabric were proof against the Indian missiles, and were adopted by the Spaniards. The nobles wore instead, cuirasses of thin plates of gold or silver with surcoats of feather-work.

Among the presents stolen or purchased by the brutal Cortez and sent to Charles V. were "cotton mantles, some all white, others mixed with white and black, or red, green, yellow, and blue; waistcoats, counterpanes, tapestries, and carpets of cotton; and the colors of the cottons were extremely fine." — CLAVIGERO'S *Conquest of Mexico*.

The Mexicans had indigo and cochineal.

Columbus found the cotton-plant wild in Hispaniola, in other West India islands, and on the continent of South America, where the natives used it for dresses and fishing-nets.

Magellan, in 1519, found the Brazilian natives reposing on beds of cotton down.

Cotton goods were familiar to the Arabs in the time of Mohammed, A. D. 627, and the culture was carried by his followers through the Mediterranean coast of Africa into Spain, whence the fabric reached the less civilized parts of Europe. Abderrahman III. commenced the manufacture of cotton in Spain, and in the fourteenth century it was introduced into Italy.

When the best part of the inhabitants of Spain were expelled, when the University of Cordova became a thing forgotten on the peninsula, when the memory of Alhazen was lost, and the era of the Pedros and Philips commenced, then the cotton-plant, too, faded away, and all the industries growing out of this beautiful staple languished. The culture and manufacture revived again in Spain at Valencia and Barcelona respectively.

Fabrics and yarns were largely imported from the East into Europe for several centuries; but the manufacture of the *cotton-wool*, as it was long called, gradually crept into the various countries of Europe.

The earliest notice in England is by Roberts, 1641, who describes the excellent goods, "*fustians, vermillions, dimities*, and other stuffs," made by the inhabitants of Manchester, of "*cotton-wool* brought from Smyrna and Cyprus." First made by machinery by Louis Paul in 1736-40. See COTTON-MACHINERY.

In the seventeenth century, cotton fabrics were so largely imported into England from India as to interfere with the woolen, linen, and silk interests, and the importation of cotton goods was forbidden in 1700.

An act of parliament in 1721 imposed a fine of £5 on the wearer of cotton and £20 on the vendor. It was thought to be the ruin of England, and every depression in trade was charged on the cotton, which was superseding wool. Thirty years afterward the annual value of manufactured cottons was £200,000. In 1860 it was £52,000,000. In 1823, Great Britain employed 10,000 steam-looms; the number in 1865 was 400,000, driven by steam-power estimated equal to 294,000 horses, and directly employing 1,000,000 persons.

The Parliamentary Report of 1851 states the number of pounds of cotton worked into yarn per day (nearly) . . . . . 2,000,000 pounds.

Spindles in operation	20,000,000
Power-looms	250,000
Factories	2,000
Hands employed inside the walls	350,000
Horse-power (steam and water)	80,000
Production of cotton goods in 1850 per day	4,000,000 yards.
Production of unwoven cotton yarn per day	500,000 pounds.

Cotton-seed was brought into England from the Levant; taken thence to the Bahamas, and thence to Georgia in 1786. The first cotton-mill in America was at Beverly, Mass., in 1788.

In the following list are associated the terms used in the description, manufacture, and products of fibrous material, excepting those involving pulping, which will be found under the indical head of PAPER (which see). The following list includes cotton, flax, wool, hemp, silk, etc., appliances. See —

Ageing.
Balling-machine.
Bat.
Batting.
Batting-machine.
Beating-engine.
Bier.
Billy.
Bink.
Bleaching.
Block-printing.
Blower and spreader.
Blowing-machine.
Bobbin.
Bobbinet-machine.
Bobbin-winder.
Bobbin and fly frame.
Boon.
Bott-hammer.
Braiding-machine.
Braid-sizing and polishing machine.
Brake. Flax and hemp
Branning.
Breaker.
Breaking-frame.
Breaking-machine.
Bronze.
Brushing-machine.
Bucking.
Bucking-keir.
Buffalo.
Bunch.
Bundle.
Bundling-press.
Burling-iron.
Burling-machine.
Burr.
Burring-machine.
Cable-laid.
Calendering-machine.
Calico-printing.
Can-frame.
Can-roving machine.
Canvas-frame.
Card.
Card-clothing.
Card-grinding.
Carding-engine.
Carding-machine.
Card-machine.
Card-setting machine.
Carriage.
Carrier.
Cask.
Caudroy.
Chamber.
Chemicking.
Chenille-machine.
China-blue style.
Circular bolt.
Clasp.
Cleaning-machine.
Clearer.
Clearing.
Cloth.
Cloth-creaser.
Cloth-crimping machine.
Cloth-cutting machine.
Cloth-dressing machine.
Cloth-drying machine.
Cloth-embossing machine.
Cloth-finishing machine.
Cloth-folding machine.
Cloth-measuring machine.
Cloth-napping machine.
Cloth-press.
Cloth-shearing machine.
Cloth-smoothing machine.
Cloth-sponger.
Cloth-stretcher.
Cloth-teaseler.
Cloth-tenter-bar.
Coiling or laying slivers.
Color-doctor.
Column.
Clouded-yarn machine.
Comb.
Comb-broach.
Combing-machine.
Condenser.
Cone-pulley.
Cop.
Copping-plate.
Copping-rail.
Cop-tube.
Cop-winder.
Cord.

Cord-covering machine.
Cord-dryer.
Cot.
Cot-roller.
Cotton.
Cotton-cleaner.
Cotton-elevator.
Cotton-gin.
Cottonizing-fiber.
Cotton-paper.
Cotton-picker.
Cotton-press.
Cotton-thread.
Counterfaller.
Craping-machine.
Creel.
Creeping-sheet.
Crisper.
Crotting.
Cross-shearing machine.
Cut.
Cutting-engine.
Damping-machine.
Dash-wheel.
Decoloring-style.
Dent.
Devil.
Discharger.
Discharge-style.
Distaff.
Doffer.
Doffing-cylinder.
Doffing-knife.
Doubler.
Doubling.
Doubling and twisting machine.
Drawing.
Drawing-frame.
Drawing-head.
Dresser. Copper
Dressing-machine.
Drum.
Drying-machine.
Dumb-singles.
Dunging.
Dust-room.
Dyeing.
Embroidering-machine.
Enleavage-style.
Equational-box.
Fabric (see list).
Faller.
Faller-wire.
Felt.
Felting-machine.
Fiber-cleaning.
Fiber. Separating animal and vegetable
Filling-engine.
Fine-drawing.
Finishing-card.
Fishing-net machine.
Flat.
Flax.
Flax and hemp brake.
Flax-cleaning machine.
Flax-cotton.
Flax-cutting machine.
Flax-dresser.
Fleece.
Flock.
Flock-duster.
Flocking-machine.
Floss silk.
Fluting-machine.
Flyer.
Fondu.
Frame.
Frizzing-machine.
Fulling.
Fulling hat-bodies.
Fulling-mill.
Fulling-stock.
Gasing.
Gig.
Gigging-machine.
Gill.
Gill-frame.
Gimp-machine.
Gin. Cotton
Glossing.
Grounding-in.
Habeck.
Hackle.
Hackling-machine.
Hair-rope picker.
Hand-spinning machine.
Hank.
Harle.
Harp.
Hatchel.
Hawser.
Hawser-laid.
Heck-box.
Heckle.
Heckling-machine.
Heddle.
Hemp.
Hemp-brake.
Hook-frame.
Hot-flue.
Iron-man.
Jack-frame.
Jack in a box.
Jenny.
Kemp.
Knitting-burr.
Knitting-machine.
Knotting.
Lace-machine.
Lag.
Lantern.
Lap.
Lap-frame.
Lapping-machine.
Lay.
Laying-machine.
Lea.
Leaver-machine.
Lewis.
Licker-in.
Linen-prover.
Lint-doctor.
Loom (see WEAVING).
Madder-style.
Mangle.
Marabout.
Mordant.
Mosaic-wool.
Mule.
Napping-cloth.
Netting-machine.
Noils.
Oiling.
Opening-machine.
Organzine.
Pad.
Packaging-machine.
Padding.
Parroting.
Picker. Cotton
Picking. Cloth
Pigment.
Pile.
Pirn.
Planking-machine.
Plaquage-style.
Plucker.
Polishing. Yarn and thread
Pouncing-machine.
Printing.
Presser-bar.
Presser-flyer.
Puffer-pipe.
Quill.
Quilting-frame.
Rap.
Raw-silk.
Reed.
Reel.
Reeling-machine.
Reëntering.
Reserve-style.
Resist.
Retting.
Ribbon.
Ring and traveler.
Ring-spinner.
Rinsing-machine.
Ripple.
Roll.
Roll-boiling.
Roller-bowl.
Rongeant-style.
Rope.
Rope-making machine.
Rope-winch.
Roving.
Roving-frame.
Scavenger-roll.
Scouring.
Scribbling-machine.
Scrimping-bar.
Scutcher.
Scutching-machine.
Shake-willy.
Shearing.
Sheeting-machine.
Shives.
Shove.
Shroud. Hawser-laid
Shuttle.
Silk.
Silk-cleaning knife.
Silk-doubling machine.
Silk-filature.
Silk-reel.
Silk-sizing machine.
Silk-sorting machine.
Silk-stretching machine.
Silk-twister.
Silk-winder.
Singeing-machine.
Singer.
Singles.
Sinker.
Sizing-machine.
Skein.
Skewer.
Skip.
Slab.
Sliver.
Sliver-box.
Slub.
Slubbing.
Slubbing-machine.
Souring.
Speeder.
Spindle.
Spinel.
Spinning.
Spinning-jack.
Spinning-jenny.
Spinning-machine.
Spinning-wheel.
Spirit-colors.
Spool.
Spooling-machine.
Spool-labeling machine.
Spoon.
Spreader.
Spreading-frame.
Spun-yarn.
Squirrel.
Steam-chest.
Steeping.
Stocking-frame.
Stocking-machine.
Stop-finger.
Strand.
Stretcher-mule.
Stretching-frame.
Strick.
Suint.
Sulphuring.
Swift.
Swimming-tub.
Swingle.
Swing-stock.
Teaseling-machine.
Tenter.
Tenter-bar.
Tewing-beetle.
Thread.
Thread-finisher.
Thread-frame.
Thread-machine.
Thread-polisher.
Thread-winder.
Throstle.
Throwing.
Thrown-silk.
Thrum.
Top.
Top-flat.
Tow.
Tram.
Twilly.
Twine-machine.
Twine-reeler.
Twist.
Urchin.
Wadding.
Wadding-sizer.
Warp.
Warp-dresser.
Warp-frame.
Warping-hook.
Warping-jack.
Warping-mill.
Warp-machine.
Waste-picking machine.
Water-frame.
Water-laid.

Water-twist.
Waxing.
Whirl.
Whirlers.
Willowing.
Willy.
Wincing-machine.
Winding-machine.
Wolf.
Woof.
Wool.
Wool-burring machine.
Wool-cleaner.
Wool-combing.
Wocl-dryer.
Wool-machinery.
Wool-oiler.
Wool-picker.
Wool-press.
Wool-sorting.
Wool-table.
Wool-washer.
Worker.
Worsted.
Yarn.
Yarn-cleaner.
Yarn-dryer.
Yarn-printing machine.
Yarn-reel.
Yarn-winder.

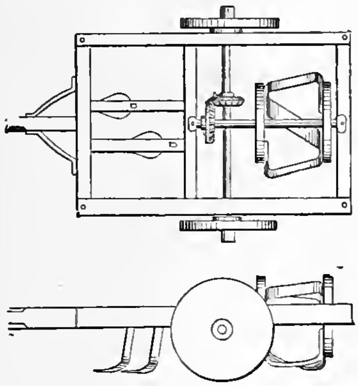
Cot'ton-ade. (*Fabric.*) Cotton check.

Cot'ton-bale Tie. See BALE-TIE.

Cot'ton-brush Chop'per. A machine with revolving knives to cut up the old dried cotton-stalks, to prepare the land for plowing for another crop.

Cot'ton-chop'per. An implement which is drawn over a drilled row of cotton-plants, and chops

Fig. 1483.



Cotton-Chopper.

gaps in the row so as to leave the plants in bunches or hills. The machine is supported on two wheels, and has a plow to run on each side of the row. Motion is communicated from the rotary axle by bevel-wheels to a revolving head having oblique cutters, which chop gaps in the row of plants as the machine progresses.

Cot'ton-clean'er. A machine for separating the dust and dirt from cotton. This is performed by a scutching and blowing action, the tussocks of cotton being torn asunder and opened, allowing the dirt to fall out. The heavier portions fall through gratings, and the lighter are carried off through air-ducts by means of exhaust-fans.

Machines for this purpose are of very variable construction, less uniformity existing in this department than in any other of the series of operations in cotton. The preliminary processes of the cotton-mill are *unpacking, sorting, picking, cleaning, willowing, batting,* and *lapping.*

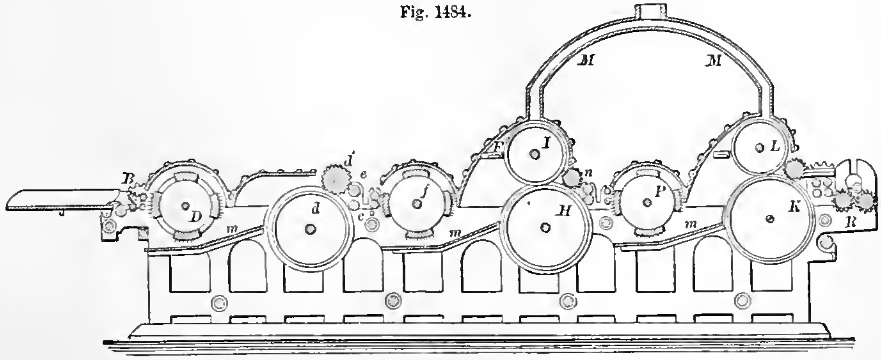
The *cotton-cleaner* (Fig. 1484) has a long series of consecutive operations. The cotton from the feeding-table is passed between a pair of fluted rollers *B*, then between smooth rollers, which present it to the action of the toothed scutcher *D*, which revolves rapidly and wafts the loosened filaments towards a wire cylinder *d*, over which it travels, being compressed by a fluted roller *d'* in its passage, and thence between a pair of smooth rollers *e*, which condense it into a *bat* ready for a repetition of the operation. Passing between another pair of rollers, the web of cotton is presented to the second scutcher *f*, which has finer and more numerous teeth, and drives the fibers forward to the wire cylinders *H I*, a knife *C* keeping clear the lower roller of the last feed-pair. The dirt falls between the bars of the gratings *m*, over which the cotton passes successively as it comes from the consecutive scutchers, and the lighter dust passes through the meshes of the wire cylinders *H I K L*, an exhaust-draft of air operating from the periphery of the cylinders inward, and the dust passing off by ducts to the case in which the exhaust-fan rotates, and thence by a suitable chute to the open air or cellar.

A deflector *F* prevents the passage of the cotton upward to the chute, forming a wiper for the cylinder *I*. The bat of cotton, by passing between *two* wire cylinders, is subjected, on its upper and lower surfaces respectively, to a drawing action, which removes the dust, and is believed to accomplish it more perfectly than when the operation is confined to one side of the bat, a single cylinder being employed.

The bat from the cylinders *H I* is subjected to the pressure of a toothed roller *n*, which acts as a doffer to the upper cylinder, and thence passes between a pair of condensing rollers, which compact it previous to a repetition of the operation.

A third set of feed-rollers next present the bat to scutcher *P*, which delivers the filaments, thus opened for the third time, to the wire cylinders *K L*, whence it issues in a partially compacted wad, and is passed, by the fluted doffer and two pairs of

Fig. 1484.



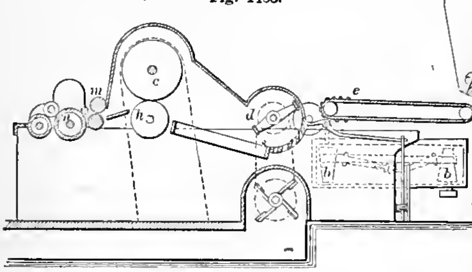
Pilson's Cotton-Cleaner.

pressure-rollers, to the lap-roller *R*, on which it is wound, ready for the operation of carding.

Another machine has a device for regulating the speed of the feed-apron by the weight consequent upon the thickness of the layer of cotton presented, the object being to present equal quantities in equal times to the *licker-in*. The concave *s* is supported on a center, and its oscillations affect the position of the band on the cone-pulleys *b* below, so as to vary the speed of the traveling feed-apron *e*.

As the cotton passes beyond the roller, it is struck by the arms of the scutcher *d*, and delivered on to the grid *s*, whose bars are longitudinal and offer no obstacle to the motion of the fibers, while the spaces allow the dirt to fall. The cotton then passes between the surfaces of the

Fig. 1485.



Lord's Cotton-Cleaner.

wire cylinders *c h*, which have an internal exhaust to remove the dust. From thence the bat passes to the pair of condensing-rollers *m*, and then to the lap-roller *n*, on which it is wound.

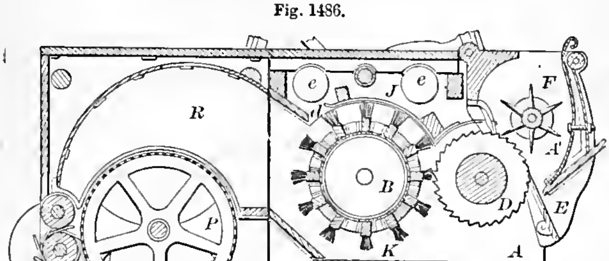
Cot′ton-ee. (*Fabric.*) A Turkish fabric of cotton and silk satinet.

Cot′ton-el′e-va′tor. An arrangement in a cotton-mill of a tube with air-blast or spiked straps for carrying cotton to the upper stories.

Cot′ton-gin. A device, originally invented by Whitney, 1794, in which lint is picked from the seed by means of saw-teeth projecting through slits in the side of the chamber in which the seed-cotton is placed.

In the example, the cotton occupies chamber *F*, where the picker-roll *A′* rotates. *E* is a grid form-

Fig. 1486.

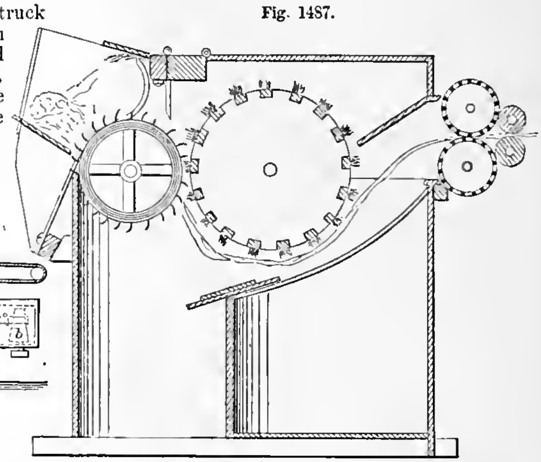


Cotton-Gin.

ing one side of the chamber, and through its intervals pass the teeth of the saws *D*, which are arranged in a row upon a mandrel driven by the motor. The fibers of lint being drawn by the teeth between the bars of the grid *E* are brushed from the saw by the rotating brush-cylinder B, and the heavier specks fall upon the mote-board *K*, while the lint and dust pass to the chamber *R*, and fall upon the wire-gauze surface of the cylinder *P*, the dust passing through and being conducted out of the machine, while the lint is arrested and passes to the doffing and compacting cylinders, from which it issues as a bat.

In Fig. 1487, instead of saws are needle-pointed teeth. The teeth are set obliquely to the radial

Fig. 1487.



Cotton-Gin.

lines of the ginning-cylinder, which is composed of segments of rings which admit of separate removal. The cotton is doffed by a brush-cylinder, and received by and condensed between two smooth cylinders, which make it into a bat and allow the dust to pass off.

Cot′ton-hook. A claw with a handle, by which cotton-bales are moved in loading and shipping.

Cot′ton-iz′ing Fi′ber. A process of disintegrating fiber, adopted with flax, hemp, jute, cane, etc., so as to reduce them to a short staple resembling cotton, which can be worked on cotton-machinery.

P. Claussen's patent, 1851, No. 8134, describes a process for reducing vegetable fiber to a condition for being spun or felted, by saturating it with a solution of carbonate of soda and potash, and then to a solution of sulphuric acid, so as to generate carbonic-acid gas within the cellular structure, and thus tear it to pieces and dissolve the mucilaginous matters. See Flax-cotton.

Lyman's patent, August 3, 1858, is for what is called the "fiber-gun." Wool, flax, hemp, jute, cane, etc., are confined in a cylinder, and charged with steam at a very high pressure. By a sudden movement, the material is released and explodes into a chamber, the violent expansion rupturing the cells and reducing the material to a disintegrated condition.

There are many modifications of the alkali and acid treatment, and of the resulting washing, bleaching, and drying processes, by which mucilage, color, and silex are removed.

Cot′ton-ma-chin′er-y. The progress of a bale of cotton to the condition of thread or yarn may be briefly stated as follows: —

1. *Sorted* and mixed, to give uniform quality to a given lot. The cotton is piled in layers in a *bink*, and, in taking it from the side of the heap, the cotton of the several strata is an average of the whole.

2. *Scutched* or *willowed*, to tear the matted masses apart and open out the fibers.

3. *Cleaned* and *batted* by a combined tearing and blowing action.

4. The bat is farther treated in a similar manner, the filaments being more divided, received on a wire-gauze drum, pressed into a thin sheet, and delivered as a *lap* upon a roller.

5. *Carded*, to straighten the fibers, which are delivered in *fleeces* or *slivers* by the *doffer*; that is, in broad or narrow films or transparent sheets of fiber; or the *fleece* is reduced to a *sliver* by being passed through a funnel and consolidated by rollers.

6. *Doubled* and *drawn*, to complete the parallelism and elongate the ribbon. By the repetition of this process, the possible inequalities of separate ribbons are lost by throwing them together and re-drawing again and again, and depositing in cans.

7. *Roving*, to attenuate and slightly twist the spongy cord and wind it on bobbins.

8. *Fine-roving* and *stretching* by the *bobbin-and-fly* frame or the *stretcher-mule*, delivering on bobbins.

9. *Spinning* in the *throstle*, which continuously *draws*, *twists*, and winds the yarn (for warp); or in the *mule*, which *draws* out and *twists* lengths of about 56 inches, and then winds upon the spindles (for weft).

10. *Winding*, *doubling*, and *singeing* the yarns, to fit them for the weaver.

11. Packing.

12. Dressing.

13. Warping.

14. Weaving.

N. B. There are many varieties and differences in machines and processes, and some even in the order of details. Much difference also exists in the machines for finer or coarser work, so that, while the above list is substantially accurate, it will not be found to agree with the order of all factories, and perhaps not in every respect with any one.

The inventions involved in the treatment of cotton by machinery are about as follows: —

Fly-shuttle, John Kay, of Bury, 1738.
Carding-machine, Lewis Paul, 1738.
Drop-box, Robert Kay, 1760.
Spinning by rollers, Lewis Paul or John Wyatt, 1738.
Spinning-jenny, Hargreaves, 1767.
Water-frame, Arkwright, 1769.
Power-loom, Rev. D. E. Cartwright, 1785.
Cotton-gin, Eli Whitney, 1794.
Dressing-machine, Johnson and Radcliffe, 1802–1804.
Power-loom, Horrocks, 1803–1813.
Mule, Samuel Crompton, 1774–1779.
Self-acting mule, Roberts, 1825.

See COTTON, FLAX, WOOL, HEMP, SILK, ETC., APPLIANCES, p. 631.

A cotton-factory cited by Ure has machines in the following proportions: —

1 *willow*, 1 *blowing-machine*, 1 *lap-machine*, capable together of cleaning and lapping 9,000 pounds of cotton per week.

21 *cards*, *breakers*, and *finishers*; joint capacity 5,000 pounds per week of 69 hours.
3 *drawing-frames* of 3 heads each.
2 coarse *bobbin-and-fly frames*.
7 fine *fly-frames*.
12 self-acting *mules*; 404 spindles each.
10 *throstle-frames*; 236 spindles each.
7 *dressing-machines*.
236 *power-looms*.
2 *warping-mills*.
300 *warp-winding* spindles.

The rovings have four hanks in the pound, and are spun into yarn No. 38 on the throstles as well as by the mules.

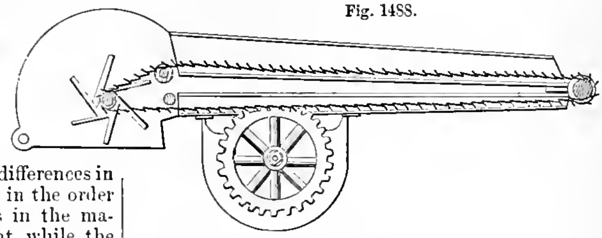
Cot'ton Pa'per. We are indebted for cotton paper to the Arabians, and it is surmised that they learned it of nations still east of them. The use of cotton for this purpose was probably derived from "far Cathay" (China), whence we received gunpowder, porcelain, the mariner's compass, and the art of glazing earthenware.

The first use of cotton paper in Europe was among the Saracens in Spain, and cannot be traced back beyond the tenth century. In Europe, it preceded the use of flax fiber for that purpose. The paper of Xativa, a city of Valencia, was famous in the twelfth century. See PAPER.

Cot'ton-pick'er. 1. A machine for scutching cotton to tear apart the matted masses and clean it. See COTTON-CLEANER.

2. A machine for picking cotton from the bolls of the plant. One form consists of a traveling toothed belt, which catches the cotton fiber and drags it into a receptacle. This form is shown in Fig. 1488, which has a toothed wheel working into

Fig. 1488.



Cotton-Picker.

the links of an endless chain having reflex spines, which strip the cotton from the bolls, and carry it to the other end of the machine, where it is thrown off into a receptacle by a revolving stripper.

Other machines have rotary brushes, and still others operate by blowers, flexible air-pipes, and nets which catch the fiber.

Cot'ton-press. One in which cotton is baled for transportation and storage.

There are various forms of cotton-presses, known as the screw, toggle, beater, revolving, hydraulic, portable, double-acting, windlass, rack-and-pinion, re-pressing, and rolling-pressure presses. See under those heads respectively.

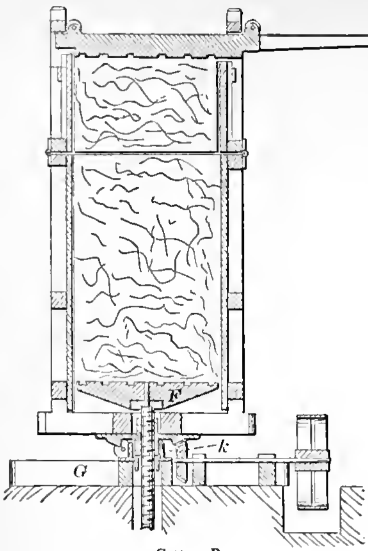
The old form of press was the screw, which ascended vertically from the follower and worked in a nut in the upper cross-beam. It was rotated by a sweep.

In the illustration is a modern form of the screw-press, which leaves the upper end of the box open for filling, the screw working from beneath.

The cotton is confined in a long rectangular chest that revolves on a vertical axis, engaging a screw that drives the follower.

The bevel-wheel *k* is driven by the shaft and band wheels, and engages another bevel-wheel, which is secured, teeth down, beneath the sill-framing of the box, which runs on rollers on the rim of the curb *G*. As the box rotates, the screw rotates in its nut, and elevates the follower *F*.

Fig. 1489.

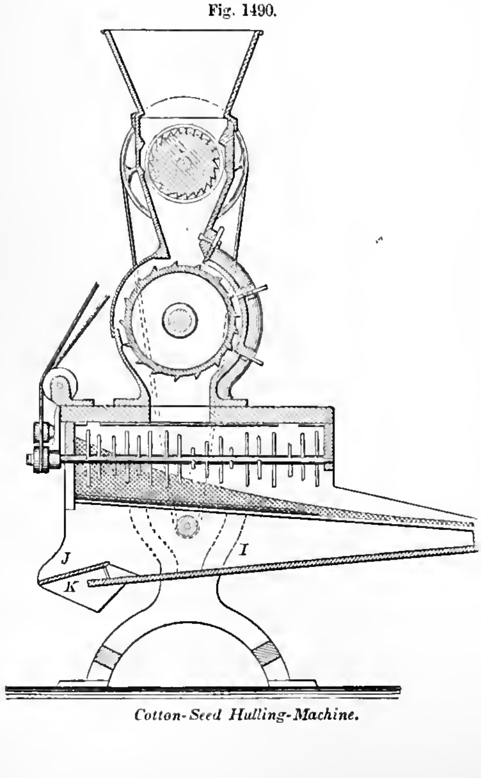


Cotton-Press.

Cot'ton-seed Clean'er. A machine for tearing the remaining fiber from the cotton-seed, or one which so far compacts the fiber upon the seed that the latter will roll upon itself without making a mat, and so become fitted to be sown by an ordinary machine.

Cot'ton-seed Hull'er. A machine by which the hull of the cotton-seed is rasped off and sifted from the farinaceous and oily matters, which are

Fig. 1490.



Cotton-Seed Hulling-Machine.

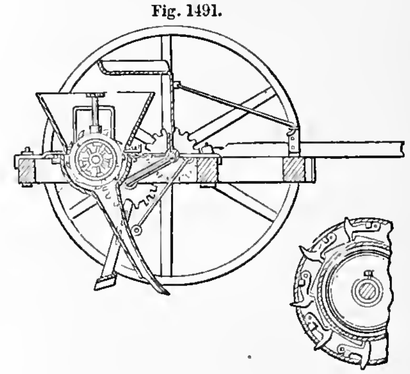
utilized for their oil and the refuse for manure. The kernels pass through the screen, while the coarser hulls and fibers are carried along and discharged from the lip of the screen. The hulled seed is then received into the box-screen *I*, which, being shaken by suitable mechanism, separates the still remaining lighter portions of the hulls that pass the wire screen, carrying these portions out over the apron *J*, while the cleaned and hulled seed passes out through the chute *K*.

Cot'ton-seed Mill. One for grinding the seed of cotton, either for manure or for obtaining from the meal the oil, either by pressure or the more usual mode of treatment by bisulphide of carbon (Sim's process) or hydrocarbon.

Cot'ton-seed Plant'er. One in which the feed-motions are positive, as the seed adheres by the interlacing of its fibers, and requires to be torn apart and driven down the chute to the ground.

In Fig. 1491, the adjustable teeth are arranged within a case in a hopper, and are operated by gear-

Fig. 1491.



Cotton-Seed Planter.

ing in connection with the driving-wheel, and regulated by cams secured to the case, whereby the cotton-seed is projected down the tube. Rotating arms work in the case, preventing choking therein.

Cot'ton Thread. Cotton thread for sewing is made by laying together two or more yarns of equal quality and twisting them. Previous to the doubling and twisting, the yarn is passed through a trough containing a thin solution of starch. The twist is given in an opposite direction to that applied by the spinning-machine, as in the case of organzine silk.

Cot'ton-top'per. A machine which passes along and prunes the row of growing cotton-plants, in order to curb its rampant luxuriance.

Cot'trel. A hook and trammel for suspending a cooking-vessel.

Couch. 1. (*Malting.*) The heap of steeped barley on the floor where the grains undergo germination, effecting the change into *malt*. The operation of *couching* takes about fourteen days, and the subsequent kiln-drying, which arrests germination, takes two days.

2. (*Paper-making.*) To take the flake of imperfectly compacted pulp from the mold or apron on which it has been formed.

With hand-laid paper this is the business of the *coucher*, who receives the mold from the *dipper* and *couches* the sheet upon a *felt*.

In paper-machinery the operation is performed by a roller called the *couching-roller*.

3. A reclining seat, bed, or sofa.

The Greeks adopted the couch from the Persians.

"After this had been said, Cymilcus asked for some spiced and boiled water to drink; saying he must wash down all those salt arguments with sweet drink. [Salted fish had been the subject under discussion.] And Ulpian said to him with some indignation, and *slapping his pillow with his hand*, 'How long will it be before you leave off your barbarian tricks?'" — *Deipnosophists*, III. 94.

4. (In *painting*, etc.) The ground or base on which the color is applied; a varnish or sizing. The term is also used in leather-gilding, gold-wire drawing, and other mechanical arts.

Couch'ing-in'stru-ment. One employed in depressing the opaque lens in cataract previous to removal.

Cou-lisse'. 1. A grooved piece of timber.

2. A pair of battens, or a groove in which a sluice-gate moves up and down.

Cou-lomb's Bal'ance. The torsion-balance; a form of ELECTROMETER (which see).

Coun'ter. 1. (*Shipbuilding.*) That part of a ship's stern which overhangs the stern-post. The *counter*-timbers spring from the *wing-transom*, which extends across between the fashion-pieces, crossing in front of the *stern-post*, near its head. At the top of the *counter-timbers* is the *taffrail*.

2. A bench or long table on which merchandise is exhibited or money-affairs transacted.

3. The back part of a boot or shoe, around the heel of the wearer, and to which the boot-heel is attached.

4. An apparatus attached to a steam-engine, printing-press, or other machine, for the purpose of counting the revolutions or pulsations, as the case may be. A game-scorer.

5. (*Mining.*) A cross vein.

Coun'ter-bal'ance. A weight in a driver or fly-wheel to overcome a dead point, or balance the weight of some object whose gravity affects the opposite side of the wheel.

A suspended weight to counterpoise the weight of a drawbridge, crane-jib, bob, or working-beam.

Coun'ter-bat'ter-y. A battery at the crest of a glacis, to silence the fire of the besiegers, and cover the storming party.

Coun'ter-beam. (*Printing.*) A beam connected to the platen by two or more rods, through the medium of which the reciprocating motion is communicated to the platen.

Coun'ter-brace. (*Nautical.*) The brace of the foretopsail to leeward.

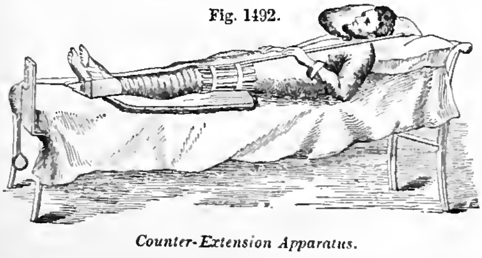
Coun'ter-check. A plane for working out the groove which unites the two sashes of a window in the middle.

Coun'ter-die. The upper die or stamp.

Coun'ter-drain. (*Hydraulic Engineering.*) A drain at the foot of a canal or dike embankment, to catch and carry off the water.

Coun'ter-ex-ten'sion Ap-pa-ra'tus. For retaining firmly the upper part of a limb while extension is practiced upon the lower, in cases of fracture of the femur or the neck of the trochanter major, to enable the bony parts to unite without a shortening of the limb. It consists of coaction-splints for the femur (if that be the seat of the accident); a counter-extending band attached to the bed-head; and a round perineal band which passes around the crotch; an extending band fastened by starch bandage to the lower leg; a wooden block on the foot-sole, connecting the band to an extension cord, which runs over a pulley on the bed-foot.

Fig. 1492.



Counter-Extension Apparatus.

Coun'ter-fal'ler. (*Cotton-manufacture.*) In the mule-spinner, a counterweighted wire, which is depressed when the *faller-wire* lowers the row of yarns to wind them on the cop. Its duty is to balance the threads after they are depressed by the *faller-wire*, and to straighten them when loose.

Coun'ter-fort. (*Masonry.*) A pier or buttress bonded as a revetment to the back of a retaining wall, to support and also tie the wall, such as the scarp of a fort, to the bank in the rear.

The buttress is sometimes on the face. When arches are turned between counterforts, it is called a counter-arched revetment.

Coun'ter-gage. (*Carpentry.*) An adjustable, double-pointed gage for transferring the measurement of a mortise to the end of a stick where a tenon is to be made, or *vice versa*.

Coun'ter-guard. (*Fortification.*) A rampart in advance of a *bastion* and having faces parallel thereto.

Coun'ter-mine. (*Fortification.*) A mine by the besieged, to meet an approach, destroy an offensive position, or intercept a mine of the attacking party.

Coun'ter-mure. (*Masonry.*) The facing of a wall.

Coun'ter-pane. A coverlet, sometimes woven in raised figures. A quilt; a spread.

Counterpane-weaving is with two shuttles, one holding a much coarser weft than the other. The coarser is thrown in at certain intervals, and the thread is picked up with an iron pin, rather hooked at the point, so as to form knobs disposed in a sort of pattern.

Coun'ter-poise. A balance-weight upon a wheel or beam, as on the driving-wheel of a locomotive, etc. A *counterbalance*.

Coun'ter-poise-bridge. A *bascule*-bridge; the platform is raised by machinery or otherwise, the operation being assisted by counter-weights. See BASCULE; LIFTING-BRIDGE.

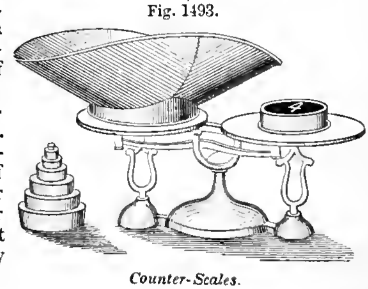
Coun'ter-proof. One taken by transfer from another proof just printed. The object is to furnish an engraver with a copy, non-reversed, of his plate.

Coun'ter-punch. (*Chasing.*) One which supports the metal beneath while the hammer is applied above, and may be the means of expanding a dented place by outward pressure while blows are given on the outer surface around the spot thus supported.

Coun'ter-rails. (*Shipbuilding.*) The ornamental molding across a square stern at the termination of the counter.

Coun'ter-scales. A convenient form of scales for counter or table use. It has many forms.

Fig. 1493.



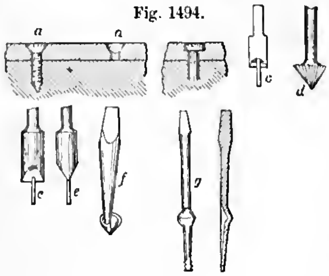
Counter-Scales.

Coun'-ter-scarp. (*Fortification.*) The wall on the outer side of the ditch, opposite to the *scarp*, which is on the fort side.

Coun'ter-shaft. An opposite and parallel shaft driven by band or gearing from the former one.

Coun'ter-sink. 1. An enlargement of a hole to receive the head of a screw or bolt.

Fig. 1494.



Countersinks.

The sides of the hole are merely chamfered (*a a*) when it is to receive the head of an ordinary wood screw.

When a flat-head screw or a bolt-head is to be let in flush with or below the surface, a flat bottom *b* is required.

2. A tool for making a countersink depression.

In watch-making, the countersinks *c c* are of the flat-bottom class; a central stem passes into the hole for the shank of the screw, and acts as guide for the cutting edge. *f* is a tapering countersink formed by a wing twisted into a spiral cutting edge.

Coun'ter-sink-bit. A boring-tool having a conical or cylindrical cutter, which makes a depression to suit the head of a screw. See *c d c f g*, Fig. 1494.

Coun'ter-sunk-head'ed Bolt. A bolt having a beveled head, which is let into a corresponding cavity in one of the pieces which it binds together. See BOLT.

Coun'ter-sunk Nail. A nail with a conical head like a wood-screw.

Coun'ter Swal'low-tail. (*Fortification.*) An outwork in the form of a single tenaille, with a wide gorge.

Coun'ter-tim'ber. (*Shipbuilding.*) One of the timbers in that part of a ship's stern which overhangs the stern-post.

Coun'ter-trench. (*Fortification.*) A trench made by the garrison to intercept that of the besiegers.

Coun'ter-val-la'tion. (*Fortification.*) Lines or earthworks around a fortress to repel sorties.

Coun'ter-vault. An inverted arch or vault.

Coun'ter-works. (*Fortification.*) Works undertaken for the purpose of destroying or rendering useless those of the enemy.

Count'ess. A size of slate. See SLATE.

Coun'try. 1. (*Mining.*) The rock or strata in which a metallic lode is found.

2. (*Fortification.*) The region outside of a fort down to which the glacis slopes.

Count-wheel. (*Horology.*) A wheel with peripheral notches, whose intervals are spaces whose proportions are 1, 2, 3, up to 12. The wheel governs the striking so far as to regulate the number of blows. The knife-edge detent being lifted out of a notch, the hammer vibrates so long as the edge rests on the portion of the wheel between the notches. These spaces are graduated in length, so as to allow the hammer to make 1, 2, 3, etc., vibrations up to 12, when it has completed a revolution and begins again. Seventy-eight blows are struck in a complete revolution. It is superseded in some clocks by the *rack* and *snai'*, invented by Tompion.

Cou-pe'. 1. A four-wheeled close carriage with a single inside seat and a perch for the driver.

2. The front apartment of a French diligence or an English railway-car.

Coup'er. A lever on the upper part of the loom, to raise the harness.

Coup'le. (*Electricity.*) A voltaic couple is a pair of plates forming a battery, or a part of one.

Coup'led Col'umns. Columns arranged in pairs, where the nature of the openings, doors, windows, or niches precludes the usual intercolumnar distance.

Coup'ler. 1. (*Music.*) A connection between the corresponding keys of different banks or ranks of keys, so that they act together when one is played upon. When a key of the lower bank is touched, it actuates the one above; but the action is not reciprocal. The coupler is thrown into action by a draw-stop or pedal.

Octaves in the same bank are sometimes coupled, to avoid the necessity of striking octaves by stretching the hands. Similarly, the *great*-organ may be coupled with the *choir*-organ or the swell.

2. The ring which slips upon the handles of a crucible tongs, or a nipping-tool of any kind. Also called *reins.*

Coup'les. (*Carpentry.*) Rafters framed together in pairs by a tie, which is generally fixed above the feet of the rafters.

Main couples; the roof-trusses.

Coup'ling. A device for uniting adjacent parts or objects. See under the following heads: —

Axle-coupling.
Bale-tie.
Ball and socket.
Band-coupling.
Bayonet-joint.
Belt-clasp.
Belt-coupling.
Belt-fastener.
Binding-screw.
Bolster-coupling.
Buckle.
Car-coupling.
Carriage-coupling.
Carriage-shackle.
Chain-coupling.
Clasp.
Claw for suspending tackle.
Clevis.
Clinch-ring.
Clip.
Clutch.
Clutch-rope.
Coat-link.
Connecting-link.
Connector.
Coupler.
Coupling-box.
Coupling-link.
Coupling-pin.
Coupling-pole.
Cramp.
Differential coupling.
Draft-bar.
Draw-bar.
Draw-link.
Expansion-coupling.
Felloe-coupling.
Fetter.
Fish-bar.
Fish-joint.
Flexible coupling.
Friction-clutch.
Friction-coupling.
Gimbal.
Gimmal.
Gland.
Grappling-iron.
Gripes.
Gyves.
Hame-fastening.
Hand-clamp.
Hand-cuff.
Harness-snap.
Hasp.
Hinge.
Hook (varieties, see HOOK).
Hopple.
Hose-coupling.
Jew's-harp-shackle.
Joint (varieties, see JOINT).
Joint-coupling.
Key-coupler.
Knuckle-joint.
Lap-ring.
Lengthening-rod.
Link.
Manacles.
Oldham's coupling.
Open ring.
Parral.
Perch.
Pipe-coupling.
Pitman-coupling.
Rail-coupling.
Reach.
Reins.
Ring.
Rod-coupling.
Screw-coupling.
Shackle.
Shaft-coupling.
Shank-coupling.
Snap-hook.
Snap-link.
Spiral-spring coupling.
Split-pin.
Split-ring.
Spring-coupling.

Swivel.	Truss.
Thill-coupling.	Turnbuckle.
Tool-coupling.	Universal joint.
Tree-coupling.	Wagon-coupling.

Coup'ling-box. A metallic box into which the ends of two shafts are fastened, to couple them in line.

Coup'ling-link. An open or split link for connecting two objects, or forming a detachable section in a chain.

Coup'ling-pin. (*Vehicle.*) A bolt which fastens the hind hounds to the coupling-pole, which is attached to the fore-gears by the king-bolt.

Coup'ling-pole. (*Vehicle.*) A pole connecting the fore and hind gear of a wagon.

Coup'ling-strap. A strap connected to the off bit-ring of the off horse, thence through the near bit-ring, and leading back to the harness of the near horse. Used with artillery horses, and also for restive horses in ordinary service.

Cou-pure'. (*Fortification.*) A passage cut through the glacis in the reëntering angle of the covered way, to facilitate sallies by the besieged. They are sometimes made through the lower curtain, to let boats into a little haven built in the reëntering angle of the counterscarp of the outworks.

Course. 1. (*Masonry.*) One row or tier of bricks or stones in a wall.

Plinth-course; a lower, projecting, square-faced course.

Blocking-course; laid on top of the cornice.

Bonding-course; one in which the stones lie with their length across the wall.

Heading-course; being all headers.

Stretching-course; consisting of stretchers.

Springing-course; upon which an arch rests

String-course; a projecting course in a wall.

Rows of slates, tiles, and shingles are also termed *courses*. The *barge*-course is one projecting over the gable of a building.

2. (*Music.*) A set of strings of the same tone placed alongside, and struck one, two, or three at a time, according to the strength of sound desired. The adjustment in a piano is made by the *soft* pedal, which shifts the bank of keys.

3. (*File-cutting.*) A row of parallel teeth on the face of a file. One *course* makes a *single-cut* file. A *course* crossing the former at right angles constitutes it a *double-cut* file.

Eight *courses* of cuts are required for a square file, *double-cut* on each side.

On the half-round files for *gulleting* saws as many as twenty-three *courses* are required for the convex side, and only two for the straight side.

4. (*Mining.*) The direction of a vein or lode.

Coursed Ma'son-ry. As distinguished from *pierre perdue*, in which the stone is cast in at random to make a foundation, as in the Plymouth and other breakwaters, the Rip-raps, etc. *Coursed masonry* consists of blocks lying on their beds in *courses*. When laid beneath the surface of the water, they are directed by operators in the diving-bell, as practiced by Smeaton at Ramsgate Harbor.

Coursed-rubble masonry is laid in courses with occasional headers; the side joints are not necessarily vertical, nor the stones in a course of an even thickness.

Cours'es. (*Nautical.*) The sails sustained by the lower masts; as the foresail, mainsail, and spanker.

Cours'ing-joint. The mortar-joint between two courses of bricks or stones.

Court-plas'ter. Silk surfaced with a solution of balsam of benzoin.

Cous'si-net'. (*Architecture.*) The impost stone on the top of a pier. *Cushion.*

Cove. 1. (*Architecture.*) *a.* A hollow forming a member of some cornice-moldings or ceiling-ornamentation.

b. The concavity of an arch or ceiling.

2. (*Shipbuilding.*) An arched molding at the foot of the taffrail. An elliptical molding sprung over it is called the *arch* of the cove.

Coved Ceil'ing. One with a hollow of about a quarter-circle running round the room, situated above the cornice, and dying into the flat central portion.

Cov'er. 1. (*Roofing.*) That portion of a slate, tile, or shingle which is hidden by the overlap of the course above. The exposed part is the *margin*.

2. (*Machinery.*) The *cap-head* or end-plate of a cylinder.

3. A lid or hatch for a coal-hole, cistern, or vault-opening.

4. A turret or cupola on a kitchen or boiling-house, pierced at the sides to let out steam or smoke.

5. (*Steam-engine.*) The lap of a slide-valve. See Lap.

Cov'ered Way. (*Fortification.*) A sunken area around a fortification, of which the glacis forms the parapet. A *banquette* on the interior slope of the glacis affords a place for the garrison to stand on while delivering a grazing fire over the *glacis*.

Cov'er-ing. (*Bookbinding.*) The clothing of the sides and back of a book with cloth, muslin, leather, paper, or other material. The cover ready for the contents is a *case*.

Cov'er-ing-strap. (*Iron Shipbuilding.*) A plate beneath the two meeting plates in a strake, to which they are riveted and by which they are connected.

Co-vet'ta. A plane used for molding framework, called also a *quarter-round*.

Cov'ing. (*Architecture.*) *a.* The overhang of the upper portions of a building beyond the limits of the ground plan.

b. The splayed reveals or inclined jambs on the sides of a fireplace. These jambs were square in the old English fireplaces. In some of the Louvre fireplaces the jambs have an angle of about 45°. These were probably erected about 1750, by Gabriel, under the orders of M. de Marigny. Gauger had previously (1715) given to the coving a parabolic curve. Count Rumford invented or adopted the inclined coving, having an angle of 135° with the fire-back, to radiate heat into the room.

Cow. 1. (*Mining.*) A wooden wedge to jam against the barrel of a *gin* or *crab*, to keep it from revolving. (Prov. Eng.)

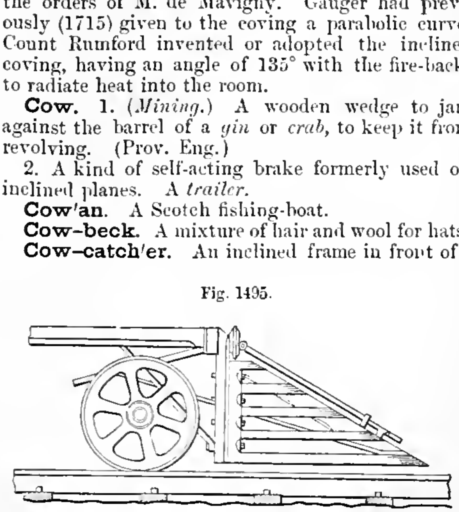
2. A kind of self-acting brake formerly used on inclined planes. A *trailer*.

Cow'an. A Scotch fishing-boat.

Cow-beck. A mixture of hair and wool for hats.

Cow-catch'er. An inclined frame in front of a

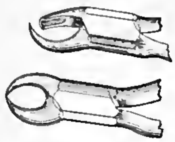
Fig. 1495.



Cow-Catcher.

locomotive, to throw obstructions from the track. A *pilot*. Patented in England by Lindo, 1840.

Fig. 1496.



Cow-horn Forceps.

Cow-horn For'ceps. A dentist's instrument for extracting molars. That for the upper jaw has one hooked prong like a cow's horn, the other prong being gouge-shaped.

The cow-horn forceps for the lower molars has two curved prongs, which hook between the pairs of side-roots of the molar.

Cowl. A chimney-cap made to turn around by the wind, or provided with ducts by which the wind is made an accessory in educting the smoke and other volatile products of combustion.

A wire cap or cage on the top of a locomotive smoke-stack.

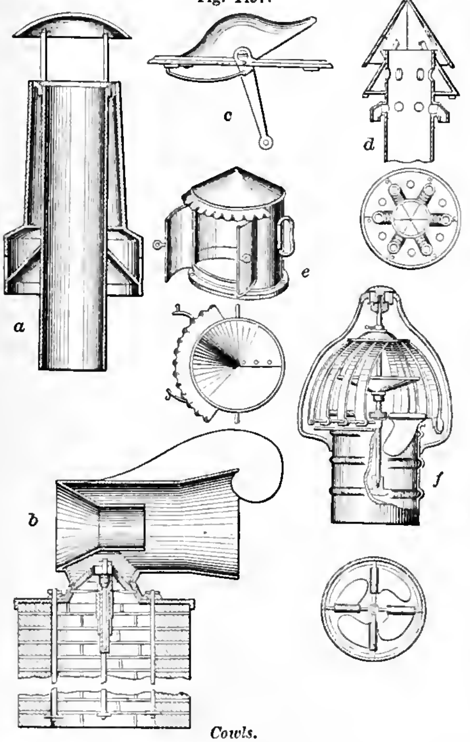
Cowls are also used on the summits of ventilating shafts for public buildings.

a (Fig. 1497). The flue has enveloping side passages which assist the draft by induction.

b. The spindle of the cowl is stepped in a socket, its collar revolving in flanges upon the upper side of the cap-plate, which is anchored to the brick-work of the chimney.

c is a cowl or hood for a car-roof, and has an adjustment by which its mouth is presented in either direction to lead in vital air, or by induction to expel foul air.

Fig. 1497.



Cowls.

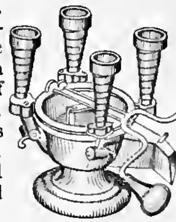
d has a circular series of openings to encourage upward draft, a deflecting frustum, and conical cap.

e is a cover for a marine stove-pipe. It is adjusted by hand so as to present the opening to leeward, and the side-wings are held open by the top-shield, which is pressed down upon them.

In *f*, the issuing current of air and smoke is deflected outward by the cone, and impinges upon the obliquely set plates of the fan-cap, causing it to revolve.

Cow-milk'er. A mechanical device for milking cows. The usual devices are on the principle of the breast-pump, with cups for the several teats. The elastic cups communicate with the conical cylinder of the diaphragm pump, the piston of which is worked by the handles. The milk is discharged by a spout into a pail beneath.

Fig. 1498.



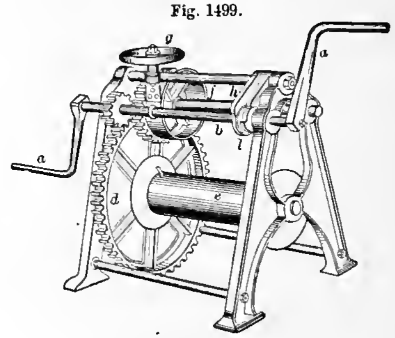
Cow-Milker.

Cown'er. The arched part of a ship's stern.

Crab. 1. A winch on a movable frame with power-gearing, used in connection with derricks and other non-permanent hoisting-machines.

The larger gear-wheel is on the shaft of the roller, and is rotated by the spur-pinion and hand-cranks.

Fig. 1499.



Crab.

2. A form of windlass for hauling ships into dock.

3. A machine used in ropewalks to stretch the yarn.

4. A claw for temporarily anchoring to the ground a portable machine.

Crack'er. 1. (*Pyrotechnics.*) A form of explosive fire-work. Marcus Græcus, in the eighth century, speaks of a composition of sulphur, charcoal, and saltpeter, which he said might be made to imitate thunder by folding some of it up in a cover and tying it tightly. This was a *cracker*.

2. A hard-baked biscuit. See BISCUIT.

3. One of the deeply grooved iron cylinders which revolve in pairs and grind the tough, raw caoutchouc, which has been previously cut in pieces by a circular knife.

Cra'dle. 1. A baby's bed or cot, oscillating on rockers or swung upon pivots.

The ancient Greeks used cradles, and called them by names indicating their forms, such as little bed, boat, etc.

Baby cradles were used by the Romans. They are mentioned by Theocritus. The cradle of Henry V. of England swung between two posts.

2. A thin shell or case of wood, acting as a splint for a broken bone or dislocated limb.

3. A framework which supports the bedclothes above an injured limb.

4. A frame on which loam-molds are placed in an oven to be burned, after the spindle is withdrawn.

5. (*Hydraulic Engineering.*) The frame in which a ship lies on the ways, and which accompanies her in launching; or, the frame in which a vessel lies on a way or slip, or in a canal-lift.

A cradle was used in very early times in crossing the Isthmus of Corinth, from the Corinthian to the Cenchrean Sea. The place was called the *Diolcos*, or drawing-place, and was five miles in length. This crossing-place was again used during the maritime warfare between the Genoese and the Turks.

At a number of places in Lombardy and Venetia the locks are insufficient or absent, and boats are cradled and transported over the grade.

The same thing takes place on the Morris and Essex Canal, which crosses the State of New Jersey, uniting the Hudson and Delaware Rivers. See INCLINED PLANE.

In its simple form, the cradle consists of three longitudinal timbers united by ribs or cross-pieces. This is floated beneath the ship, which is lashed thereto by cables. The cradle and its burden are then floated to the inclined ways or slip, up which it is hauled, being supported by rollers which intervene between the timbers of the cradle and those of the slip.

6. (*Metallurgy.*) A rocking apparatus, used in collecting gold from soil and sand by agitating the auriferous earth in water.

The earth is shoveled into the sieve, and washed through its meshes by water, which also carries off

Fig 1500.

Gold-Washing Cradle.

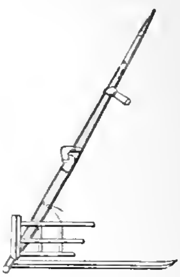
the lighter earthy particles in suspension. The coarser matters, which do not pass the meshes of the sieve, are thrown out and the operation repeated. After a large quantity of earth has been thus disposed of, the contents of the cradle are washed in a pan and the gold obtained from the settlings.

7. A tool used by *mezzotint*-engravers. It consists of a steel plate with a proper tang and handle, and has angular grooves on its under surface, so that when the rounded end is obliquely ground, it will form a row of points by which a multitude of burrs are raised upon a plate. This is the mode of proceeding in MEZZOTINT-ENGRAVING (which see), the cradle being rocked back and forth, and retreating, making a zigzag series of burrs. This is crossed at right angles, and then several times diagonally, until the whole surface of the plate is roughened, so as to hold the ink of the copper-plate printer. The burnisher and scraper remove the burr in parts, according to the desired graduation of lights.

8. A suspended scaffold used by miners.

9. (*Carpentry.*) The rough framework or bracketing forming ribbing for vaulted ceilings and arches intended to be covered with plaster.

Fig. 1501.



British Cradle.

10. (*Husbandry.*) *a.* A set of fingers projecting from a post which is mortised into the snath of a grain-scythe.

b. A grain-scythe.

The American grain-cradle is a superior implement. The English *cradle-scythe*, judging by the representations, is a far inferior tool; nothing in its execution comes up to the rate and quality of work as seen in the American harvest-field before cradles were superseded.

Cra'dle-scythe. (*Agriculture.*) A broad scythe to be fitted in a grain-cradle, as distinguished from a *grass* or *mowing* scythe.

Cra'dling. 1. (*Coopering.*) Cutting a cask in two lengthwise, in order to allow it to pass through a doorway or hatchway, the parts being afterwards united and rehooped.

2. (*Carpentry.*) The framework in arched or coved ceilings to which the laths are nailed.

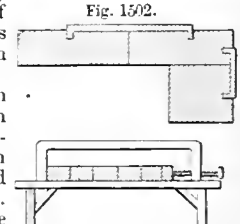
Cramp. 1. (*Masonry.*) A bar of iron with bent ends, used to unite adjacent blocks of stone in situations where they are exposed to wrenching, as in piers, wharves, light-houses, breakwaters, etc.

The stones forming the piers of the bridge of Semiramis across the Euphrates, at Babylon, were secured together by iron cramps fastened by melted lead. So said Diodorus Siculus.

Cramps of lead for fastening together the stones of masonry were found by Layard among the ruins of Nineveh. Leaden cramps were similarly used in Egypt.

The blocks included in one layer of masonry in Smeaton's Eddystone light-house were united by iron cramps, with melted lead poured around them. Wooden dowels united the layers.

Fig. 1502.



Cramps.

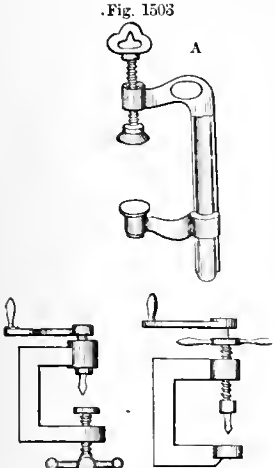
The stones in the Coliseum of Vespasian were united by bronze cramps.

2. (*Carpentry.*) *a.* A rectangular frame with a tightening screw, by which carpenters compress the joints of framework, as in making doors and other panel-work, and for other purposes. Its office is somewhat similar to that of a *clamp*.

b. A bench-hook or hold-fast. (A, Fig. 1503.)

3. (*Bootmaking.*) A piece of board, shaped like the front of a boot, over which leather is bent to form the upper of a boot or shoe. See CRIMP.

Fig. 1503



Cramp-Drills.

Cramp-drill. A portable drill having a cutting and a feeding motion. In one of the examples the feed-screw is in the lower member of the cramp-frame, and in the other one it is in the upper portion and forms a sleeve around the drill-spindle which rotates within it.

Cramp-i'ron. An iron binding two stones together in a course. It has usually turned-over ends which penetrate the respective ashlars. See CRAMP.

Cramp-joint. One in which the parts are bound together by locking-bars. See CRAMP.

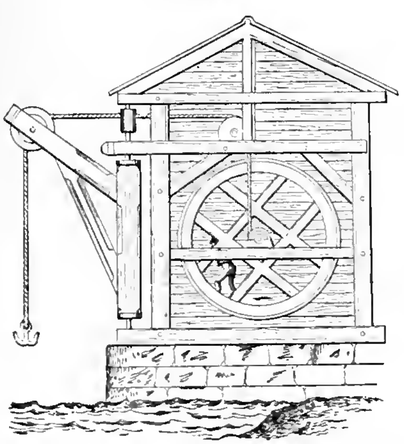
Cram'poons. 1. A clutch formed like a pair of calipers, used in raising objects.

2. Iron spikes worn on the boots, to assist the foothold in climbing the slopes of earthworks.

Cran'ber-ry-gath'er-er. An implement shaped like a rake, and adapted to catch below the berries on the stalk, and collect them in a bag or box attached to the rake-head.

Crane. 1. A machine for hoisting and lowering heavy weights. It consists of a vertical post or frame, which is rotatable on its axis, and a jib or projecting arm over which the chain or rope passes on its way from the winch at the foot of the post to the load to be lifted.

Fig. 1504.

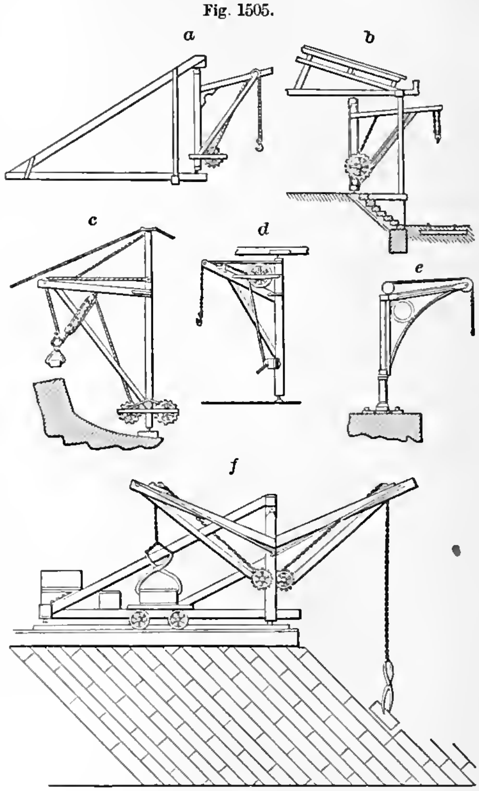


Old Dutch Crane.

The *corvus* of the Romans, which has been translated *crane*, was a boarding device, consisting of a ladder attached to a vertical spar and so pivoted as to bring the outer end over the deck of the ship to be boarded. A grappling-hook was suspended from the end of the staging. By this means of approach the Romans boarded the Carthaginian vessels, and achieved success in several naval engagements. A *corvus* was also used as a true crane for picking off soldiers garrisoning a city wall, and setting them down outside. It is described by Tacitus: —

"The stones of the pyramids were raised by making mounds of earth; cranes and other engines

Fig. 1505.



Cranes.

not being known at that time." — DIODORUS SICULUS (60 B. C.).

The old Dutch crane, which was also in use in England till the early part of the present century, was operated by a tread-wheel, around which the rope was wound; the rope then passed over guide-rollers to the jib of the crane, which projected over the hatchway of the ship and turned upon a pivot, so that it could move round about three fourths of a circle, and so deliver the goods upon the quay.

In order to lower the goods the men walked backward; but as it sometimes happened that they were overbalanced by the descending weight, a bar or pole of wood was suspended from the axle, so that in such case they might lay hold of it, and save themselves from being whirled round in the wheel.

The great wheel and the framing which supported it were contained in a wooden building, to the corner of which the jib was attached.

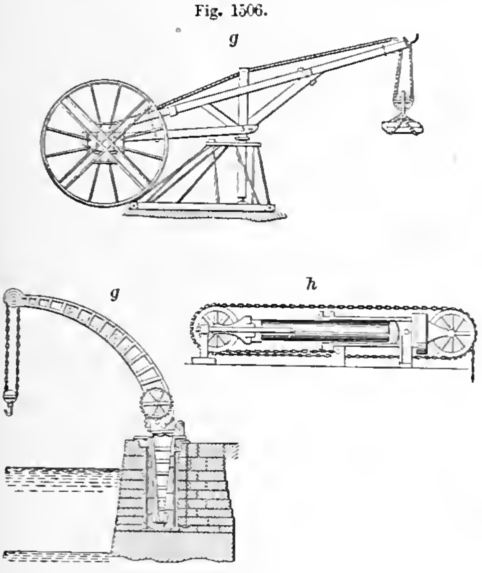
The essential features of a crane may be combined in a machine of simple construction (Fig. 1505), the central pillar being sustained by a frame of timber *a*, by a planted pillar *b*, or by guys *c*, as in the three examples of cranes of simple construction. The operation is sufficiently plain without entering into detail.

The ordinary warehouse or foundry crane (*d*, Fig. 1505) is usually stepped in the floor, and has its upper bearing in a joist or beam. Its size, proportions, and to some extent its construction, depend upon its place and application.

The application of iron in the construction of the crane causes some change in the appearance *c*, apparent lightness and compactness being gained.

The double crane (*f*, Fig. 1505) has two jibs; one of which is employed in raising a load, while the other is depositing its load in position. The crane is mounted on a carriage traversing on rails or rollers, and in the illustration is shown as applied to laying stones on a breakwater. Each jib has a

Fig. 1506.



Cranes.

sliding carriage over which the chain passes, so that the stones may be deposited either near to or farther from the shaft of the crane. This carriage is worked by a sheave and rope which passes over the point of the jib and down by the side of the spindle. The crane rotates horizontally on an axis, to bring the jibs over the places for receiving and depositing the stones respectively.

Peronnet's crane, French, (*g*, Fig. 1506,) was used by him in constructing the bridge of Neuilly. It was constructed of wood, and worked by two large wheels which had hand-pins whereby they were turned. The spindle or vertical shaft was journaled and stepped in a movable frame, and the hoisting-wheels formed a partial counterpoise for the load suspended from the end of the jib.

Fairbairn's tubular crane (lower figure *g*) is made of wrought-iron plates riveted together, and arranged so as to give the convex back and upper sides a sufficient degree of strength to resist tension, while the concave side has a cellular structure to resist compression.

Cranes were worked by hydraulic pressure as early as 1846, at Newcastle, England; subsequently the lock-gates and cranes of the Albert Dock, Liverpool, and those of the Grimsby Dock, were worked by water, derived either from the town-reservoirs or from elevated reservoirs into which it was pumped for that special purpose.

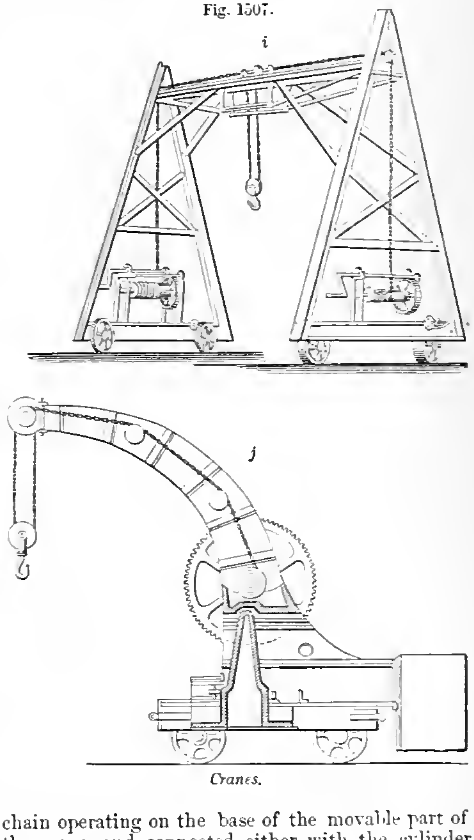
These sources, being fluctuating or expensive, gave rise to the adaptation of machinery for the purpose.

Armstrong's hydraulic crane, English, 1854 (*h*, Fig. 1506), consists of one or more hydraulic presses, with a set of sheaves used in the inverted order of blocks and pulleys, for the purpose of obtaining an extended motion of the chain from a comparatively short stroke of the piston.

In the illustration, the motion is multiplied threefold, each block having two sheaves.

Swinging the jib is effected by means of a rack or

Fig. 1507.



Cranes.

chain operating on the base of the movable part of the crane, and connected either with the cylinder and piston, having alternate motion like that of a steam-engine, or with two presses applied to produce the same effect by alternate action.

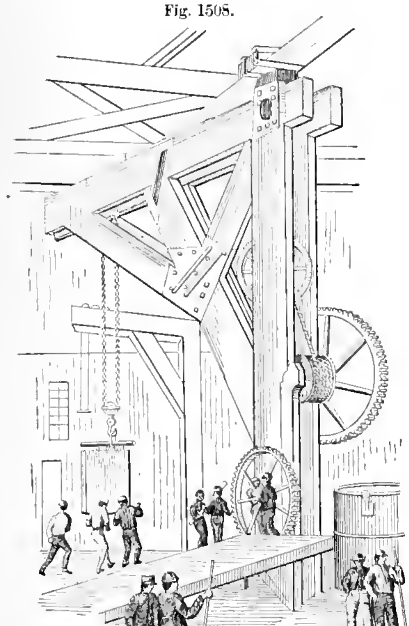
Armstrong's accumulator is intended to store the power exerted by the engine in charging it, and consists of a reservoir giving pressure by load instead of by elevation. It is a large, cast-iron cylinder fitted with a plunger, from which a heavy load-case is suspended. Water is injected by the engine, raising the plunger and the load, the effective weight of which is utilized in ejecting the water as it may be occasionally called for.

The power thus exerted in the ejection of water from the engine is usually equal to a column of water 1,500 feet high. See ACCUMULATOR.

A form of crane (*i*, Fig. 1507) traveling upon a wide-gage railroad, and bearing its load suspended from a beam above, has been adopted in some yards where heavy timber, stone, or iron require to be moved, loaded, and unloaded. The hoisting-chains are worked by winches on each section, and pass over a truck above, which has traverses on the beam, so as to bring the hook over a load nearer to or farther from the rails. By means of the traveling motion of the machine on the rails and the traversing motion of the truck above, the hook of the chain may be brought over any part of the space within the rails. If both windlasses be turned at once, the load rises. If one be unwound while the other is winding, the hook does not rise, but the truck traverses.

Fairbairn's traveling crane (*j*, Fig. 1507) is adapted for a wrecking-crane for railroad use. A crane

Fig. 1508.



Foundry-Crane.

adapted for lifting fifteen tons will have a counterweight of ten tons in the rear. In the example from which the illustration is derived, the jib swept over a circle of 25 feet diameter, and was capable of lifting the load 18 feet above the rails on the beam above, towards the winding side. By turning or unturning the respective windlasses at the necessary speeds relatively, a compound motion may be attained, towards or from either rail upward or downward.

One form of *traversing-crane* consists of a *crab* upon a carriage traveling upon rails on the beams overhead in a foundry. By the rotation of the roller of the crab, the chain or rope is wound on and the load lifted, and by the motion of the carriage is transported to any place within the range of the rails. It is known as an *overhead* crane.

The foundry-crane has a traversing carriage on the jib, which permits the point of suspension to be moved out or in from the central post; the range being from the outer end to the mid-length of the jib. The traversing-carriage is moved by an endless chain descending to the floor of the foundry.

In Morrison's steam-crane, the crane-post forms the steam-cylinder, and is fitted with a piston having a flexible piston-rod of wire rope, which works steam-tight through a stuffing-box at the top, and passes over two pulleys, itself forming the chain for lifting the load.

The downward stroke only of the piston is utilized in lifting, and the steam induction and eduction are governed by slide-valves operated by hand-levers.

In Evans's steam-crane, a vertical boiler forms the crane-post and revolves with it. The cast-iron top of the boiler has lugs for the attachment of the tension-rods. An oscillating cylinder is attached and furnishes the power.

The projecting arm or beam of a crane is the *jib*.

The *post* and *jib* collectively are sometimes known as the *gibbet*.

The diagonal is the *stay*.

2. (*Nautical.*) *a.* A forked post to support a boom or spare spar on deck.

b. A projecting bracket to support spars, etc.

3. An overhanging tube for supplying a tender with water. A water-crane.

4. A contrivance to hold a stone, and present it to the slicer of the lapidary.

It consists of a clamp which moves horizontally, having its bearings on a vertical post rising from the bench of the lapidary. A weighted string is attached to the lever-arm, and keeps the stone constantly pressed up against the slicer. See SLICER.

Crane, Der'rick. A form of crane having spars for jib and post. See DERRICK.

Crane's-bill. (*Surgical.*) A pair of long-nosed pinchers.

Cra'ni-om'e-ter. An instrument for measuring sizes of skulls.

Dr. Morton gives the following as the average result of numerous measurements of skulls: —

European	87	cubic	inches.
Malay	85	"	"
Negro	83	"	"
Mongol	82	"	"
Ancient Egyptian	80	"	"
American	79	"	"
Ancient Peruvian	75 to 79	"	"

Professor Huxley says that the most capacious European skull has a capacity of 114 cubic inches; the smallest, 55 inches. Schaaffhausen finds Hindoo skulls of 46 cubic inches.

Cra'ni-o-tome'. A cutting instrument for opening the fetal head, to assist delivery.

Crank. An arm (called the *web*) at right angles to an axis by which motion is imparted thereto or received therefrom. The crank on the axis of a grindstone or a fanning-mill is a familiar instance.

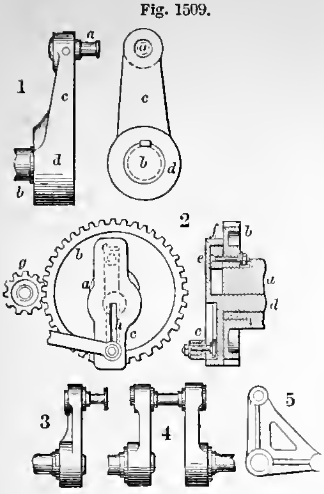
The crank is also a valued device in converting a rotary into a reciprocating motion, or conversely. An example of the former is found in the saw-mill; of the latter, in the steam-engine. Watt is the inventor of the latter application of it.

3 (Fig. 1509) shows the *single*-crank; 4, the *double*-crank; 5, the *bell*-crank.

1 (Fig. 1509), *a*, wrist or pin; *b*, shaft; *c*, web; *d*, boss.

James Watt — no mean judge — remarks that "the true inventor of the crank rotative motion was the man, whose name, unfortunately, has not been preserved, who first contrived the common foot-lathe.

Fig. 1509.



Cranks.

The applying to the steam-engine was merely taking a knife to cut cheese which h d been made to cut bread." It was a meritorious application, however, devised by Watt, to turn the reciprocating action of the piston into a rotary motion, and was stolen from him by a man who spied out the design from a sketch and conversation of Watt's workmen. Watt invented the SUN AND PLANET MOTION as a substitute (which see). See also PLANET-WHEEL AND EPICYCLOIDAL WHEEL. If the foot-lathe were the earliest form of lathe, which is not certain, and James Watt's idea were correct, which is quite probable, we may agree with one authority that the crank is as old as Talus, the grandson of Dædalus, about 1240 B. C.; or, according to Pliny, Theodorus of Samos, about 600 B. C. It must be recollected, however, that among the oldest Egyptian paintings is the representation of Thoth forming man upon the potter's wheel.

The crank was first used with the steam-engine on board the paddle-wheel steamboat of Jonathan Hull (English patent, December 21, 1736, No. 556). It did not revolve, but reciprocated, and formed an intermediate between the rope, which was pulled by the descent of the piston, when a vacuum was created in the Newcomen atmospheric engine and the leg of the propeller, which seems to have acted somewhat like the leg of a grasshopper.

A four-throw crank was employed on each end of the axis of the wallower or lantern-wheel, which was driven by the water-wheel under the north arch of London Bridge, as described by Beighton, 1731. This machine supplied a part of London with water. The water-wheel was first placed there by Morice in 1582, but it is not stated by what device the rotary motion of the wheel was converted into the reciprocating motions of the pistons in the six pumps which were operated by it.

2 (Fig. 1509) shows a combination of crank and eccentric. The boss *a*, on which turns the spur-wheel *b*, is fixed. The crank *c* turns with the spindle *d*, which is fitted eccentrically in the boss *a*. The pin *e* with the block *f* are fixed to the spur-wheel, which is set in motion by the pinion *g*. In revolving round, this wheel carries with it the crank; but, owing to the eccentricity of the two centers, the block *f* slides down the slot in the crank, and in so doing approaches nearer to the center on which the latter revolves. This has the effect that, as the angular velocity of the spur-wheel is constant, it will cause different points in the radius of the crank *consecutively* to revolve with the same linear velocity; or, in other words, will cause the angular velocity of the crank gradually to *increase* during one half of the revolution, and gradually to *decrease* during the other half. The stroke of the crank may also be varied by shifting the crank-pin in the slot *h*.

A two-throw or *three-throw* crank-shaft is one having so many cranks set at different angles on the shaft.

Crank-ax'le. 1. An axle bent down between the wheels, in order to lower the bed of the wagon and make loading more easy.

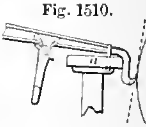
It has been introduced in England for country and city wagons, and also in the United States. It is credited to Baddeley, an early contributor to the London "Mechanic's Magazine."

2. (*Steam-engine.*) The driving-axle to which are connected the piston-rods of a locomotive engine. This is the usual English form; in America we connect to wrists on the drive-wheels.

Crank-brace. The usual form of brace, which has a bent shank by which it is rotated.

Cranked Tool. (*Iron-turning.*) A tool which is made to embrace the rest *a*, by which it is prevented from slipping away from the work. A pin is inserted in one of the holes in the rest, to prevent the escape of the tool sideways. The direct penetration is obtained by depressing the handle; the lateral motion by rotating the tool by its transverse handle, which may be a hand-vise temporarily screwed upon the shaft, or a shoulder-rest handle, as in the illustration of *heel-tool*.

Fig. 1510.



Cranked Tool.

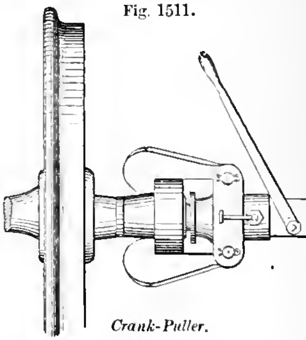
Crank-hook. The bar connecting the treadle and crank in the common foot-lathe.

Crank-pin. A pin connecting the ends of a double crank or projecting from the end of a single crank. In either case it is for the attachment of a pitman or connecting-rod. (See *a*, 1, Fig. 1509.)

Crank-pull'er. A machine for pulling the crank off an axle or shaft.

Fig. 1511 shows a hydraulic crank-puller which is portable, and therefore applicable to work *in situ*. It is shown as constructed with a 4-inch ram, and capable of exerting a force of forty tons.

Fig. 1511.



Crank-Puller.

Crank-shaft. A shaft driven by a crank, such as that of the grindstone.

Crank-wheel. A wheel having a wrist to which a pitman or connecting-rod is attached, and acting as a crank, while the peripheral portion may act as a fly-wheel, or may constitute a pulley or a traction-wheel.

Cran'ny. (*Glass-manufacture.*) A tool for forming the necks of glass bottles.

Crape. (*Fabric.*) A gauzy fabric made of raw silk, and woven without crossing.

Uncolored, or gayly dyed, it is a rich shawl-stuff.

Colored black and crimped, it is a mourning-goods. Smooth crape is used in ecclesiastical habits of a certain order, not quite so elevated as the cambric lawn of a bishop.

"A saint in *crape* is twice a saint in *lawn*."

The latter is the superlative degree of ecclesiastical habiliments in *reformed* churches.

Crisped crape denotes a poignant grief; the change to a smoother class of goods indicates that the merciful hand of Time has burnished out the wrinkles and lines of care.

Silk intended for crisp crape is more twisted than that for the smooth. The twist of the thread, especially that of the warp, is what gives the wrinkled appearance to the goods when taken out of the loom.

Aërophanes and *gauze* are goods of a similar description, either white or colored.

Crape is said to have been made by Ste Badour, Queen of France, A. D. 680. It was first made at Boulogne.

Crape-mo-rette'. (*Fabric.*) A gauzy woolen fabric of fine texture, the warp being light and open, and the weft relatively heavy and fleecy. White or colored.

Crap'ing-ma-chine'. A machine by which silk is craped, i. e. crinkled.

Crap-leath'er. Leather made from thin cowhides. Used for pumps and light shoes.

Crare. A kind of coasting-vessel, now disused.

Crash. (*Fabric.*) A heavy, coarse, plain, or twilled linen toweling or packing-cloth.

Crate. A large wicker hamper with wooden supports, in which crockery-ware is packed for transportation.

Crates among the Romans corresponded to the English *hurdles*. They were of wicker-work, and were used for screens, for leveling ground after rough-raking (*rastrum*); also as *flakes* for drying fruit. The latter were sometimes made of sedge or straw.

Large crates were used in bridging fosses, protecting military engines, etc.

Crawl. A pen of stakes and hurdles on the seaside, for fish.

Cray. A small sea-vessel.

Cray'on. 1. A colored pencil consisting of a cylinder of fine pipe-clay colored with a pigment.

Black *crayons* are colored with plumbago, or made of Italian black chalk.

A white *crayon* is a cylinder of chalk, common in England and France. Red chalk is found in France.

The holder is a *porte-crayon*.

Crayons are said to have been made in France in 1422, and imported thence into England in 1748. It is hard to say how long ago charcoal, chalk, and ochreous earths were used.

Hans Holbein drew portraits in crayon in 1540. Sir Thomas Lawrence excelled in this style of portrait-painting, 1800-1830.

2. (*Lithography.*) A composition formed as a pencil, and used for drawing upon lithographic stones. It is of a soapy nature, consisting of soap, wax, resins, and lamp-black, melted, and sometimes burned, together.

Craze-mill. A grinding-mill for tin ore.

Craz'ing. The cracking of the glaze upon articles of pottery or porcelain.

Cream-freez'er. A domestic machine in which cream is stirred in a vessel plunged in a freezing mixture, usually of pounded ice and salt.

Cream-slice. A wooden knife for dividing and serving frozen cream.

Creas'er. 1. A tool used for making single or double lines on leather, to form guides or creases to sew by.

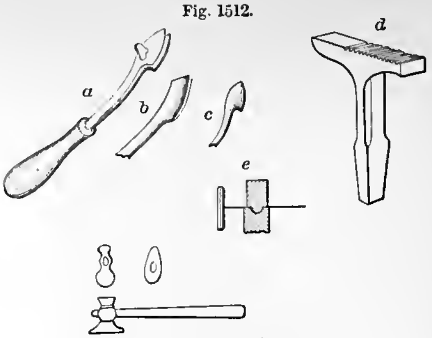
a, the adjustable double creaser, has two spring jaws, which are set open by means of a screw, so as to make the guide-lines at any required distance apart.

b is a double creaser without adjustability.

c is a single creaser.

They are also used for lining leather, to give it a finished appearance.

Fig. 1512.



Creasing-Tools.

2. *d* is used by sheet-iron workers for rounding small beads and tubes. Its shank has a tang by which it is secured in a square socket of the work-bench.

Top and *bottom creasing tools e*, of any suitable size and pattern, may be set in the jaws of a creasing-swage, the lower end of whose frame has a tang to set in the work-bench, while the upper hinged portion carries the top tool and is struck by a hammer.

The lower figure is a tool similar to the chisel, but having a blunt, rounded edge, employed by blacksmiths for making grooves in hot iron.

3. (*Bookbinding.*) A tool for making the band-impression distinct on the back.

4. (*Sewing-machine.*) An attachment which makes a mark in a line parallel with the work in hand, to indicate the place for the next seam or tuck.

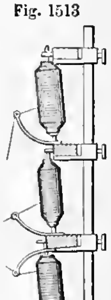
Creas'ing. A layer of tiles forming a corona for a wall.

Creas'ing Ham'mer. A narrow, rounded-edge hammer, used for making grooves in sheet-metal.

Creaze. (*Mining.*) The tin in the middle part of the buddle.

Creel. 1. (*Spinning.*) The bar which holds the paying-off bobbins in the *bobbin-and-fly*, the *throstle* machine, or the mule. In the first machine the bobbins hold the *sliver*, which is to be spun and twisted into a *roving;* in the latter machines, by a substantially similar operation, the *roving* is converted into *yarn*. The creel may have several bars with rows of skewers, upon which the bobbins are placed to unwind their contents.

Fig. 1513



Creel of Mule.

2. A fish or root basket.

Creep. (*Mining-engineering.*) The curving upward of the floor of a gallery, owing to the pressure of superincumbent strata upon the pillars. Opposed to *thrust*, which is a depression of the roof.

Creep'er. 1. A four-clawed grapnel or drag, used in dragging the bottom of a harbor, pond, or well, to recover anything which has been lost overboard, or the body of a drowned person.

2. *a.* An iron bar connecting the andirons.

b. Small dogs, with low necks or none at all, used between the usual andirons to support brands above the hearth.

3. An endless, moving feeding-apron, or a pair of aprons arranged one above the other, having motion to feed fibers to or from a machine; *e. g.* the *creeper* which feeds the *sliver* or sheet of fibers from the doffer of a carding-machine. See LAP.

4. A small sole or piece carrying spurs, which may be attached to the boot, to prevent slipping on ice.

Creep′ing. (*Nautical.*) Dragging by grapnels for the recovery of a lost cable or rope.

The most remarkable instance on record is the recovery of the Atlantic cable, broken in mid-ocean.

Creep′ing-sheet. The feeding-apron of a carding-machine.

Cre-mail-lere′. (*Fortification.*) An indented horizontal outline.

Cre-mo′na. A violin of fine quality, named from *Cremona*, Italy.

Not to be confounded with the *cromorna* stop of an organ; named from the resemblance of its *timbre* to the German *krumm-horn*, a crooked horn.

Cren′e-lat′ed Mold′ing. A kind of molding in which the beads have rectangular dentations.

Cre-nelle′. (*Fortification.*) A loop-hole in a parapet wall or stockade through which to discharge musketry.

Cre′o-sote-ap-pli′ance. A dentist's instrument intended to prevent fluid caustics, such as creosote or solution of nitrate of silver, from running down and cauterizing the lips when being applied to the gums. A spiral platinum-wire carries the sponge, and a glass tube attached to the handle and surrounding the wire catches any of the caustic which may run down the wire.

Cre′o-sot′ing. A mode of preventing decay of timber by saturating with creosote. This is said to coagulate the albumen, absorb the oxygen, resinify in the pores of the wood and exclude air, and act as a poison to prevent fungi, acari, and other parasites.

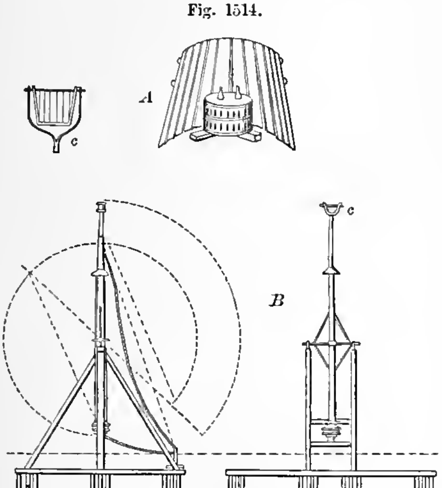
Cre′pon. (*Fabric.*) A thin stuff resembling crape, made of wool, silk, or mixed.

Cre-quil′las. (*Fabric.*) A light, low-priced cotton fabric.

Cres′cent. A musical instrument, consisting of a staff with arms and suspended bells, used in a band.

Cres′set. 1. A basket of open iron-work in which wood or coal is burned as a beacon. It was

Fig. 1514.



Cresset.

formerly used where lighthouses are now erected, and its modern use is principally at wharves and boat-landings.

A hoisting arrangement for a cresset in which a beacon-fire is kept burning is shown in the illustration *B*. The pivots of the cresset *c* are above its center of gravity, so that it swings level, whatever may be the position of the mast. The mast itself is so pivoted as to swing 120° in a vertical plane, being operated by a winch and ropes. It is brought down within convenient distance, that the fire may be replenished, and is again elevated for service.

2. (*Coopering.*) An iron basket or cage *A* to hold fire, char the inside of a cask, and make the staves flexible.

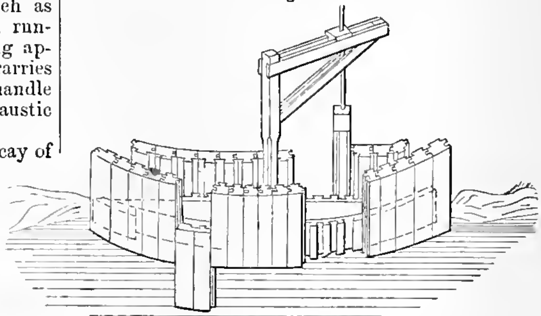
Crest. 1. The ridge of a roof; hence *crest*-tiles, which lie on the comb of the roof and shed water both ways.

2. The top of a parapet, embankment, slope, or wall. (See Fig. 2.)

Crest-tile. A saddle-tile, one having a double slope, on the ridge of a roof.

Cre-vasse′-stop′per. A kind of floating-dock which is brought broadside against the bank and

Fig. 1515.



Crevasse-Stopper.

sunk in place, to act as a dam. When it is fairly anchored, the sheet-piling is driven down into the bed both on the chord and arc side of the structure.

Crev′et. A crucible or melting-pot.

Crib. 1. A child's cot.

2. The rack or manger of a stable.

3. A granary with slatted sides for ear corn.

4. A reel for winding yarn (Scotland).

5. A small raft of timber (Canada).

6. A structure of logs to be anchored with stones. Cribs are used for bridge-piers, ice-breakers, dams, etc. See DAM.

Crib′bing. Internal lining of a shaft with frame-timbers and plank-backing, to prevent caving, stop percolation of water, etc. The different styles are known as *spiking-cribs*, *wedging-cribs*.

Crib′ble. (*Mining.*) A sieve.

Crib-strap. (*Menage.*) A neck-throttler for *crib-biting* and wind-sucking horses.

Cric. The inflecting ring which turns inward and condenses the flame of a lamp.

Crick. A small jack-screw.

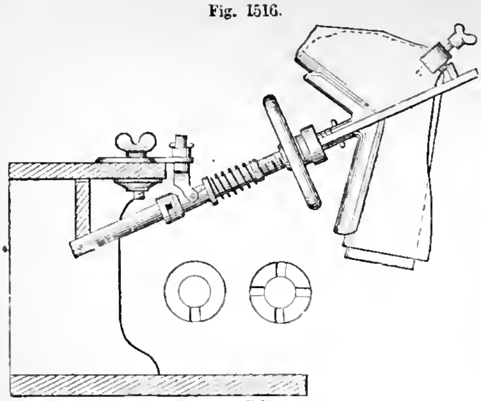
Crick′et. 1. An ancient English national game, said to be identical with the "club-ball" played in the fourteenth century.

2. A low stool, or a low table or portable shelf for kitchen uses.

Crimp′er. 1. (*Shoemaking.*) A curved board over which the *upper* of a boot or shoe is stretched, to give it the required shape.

In the common form the wetted leather is stretched by the pincers and by rubbing, and tacked on the edges to hold it till dry. Many patented boot-crimps have been introduced to expedite the process, as in the apparatus (Fig. 1516) which is

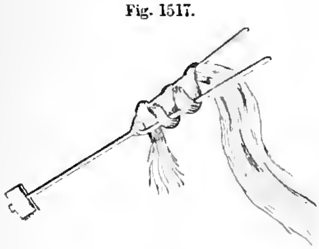
Fig. 1516.



Boot-Crimp.

applied to the bench by a swivel-device, which permits the whole to be turned to the right or left as the work proceeds. The curved bar which supports the form upon which the leather is crimped has its groove lined with rubber, which prevents the wrinkling of the leather while undergoing the stretching process. A spiral spring is employed to hold together the two parts of a clutch, and thus retain the work rigidly in any position, but adapts the clutch to be disengaged to allow the shaft to be turned to bring the work in convenient positions for the operator. The yoke which clamps the form to its support can be adjusted at will, without interfering with its hold upon the form.

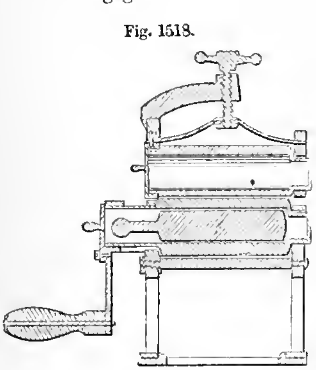
Fig. 1517.



Hair-Crimper.

2. (*Toilet.*) A fork, a pair of needles, or a pinching device in which hair is braided to acquire a wavy appearance.

Fig. 1518.



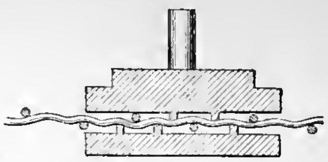
Cloth-Crimper.

The hair-crimper (Fig. 1517) has a catch-bar pivoted to the bow of the hair-pin. The hair, being wound upon the two legs of the hair-pin, is pressed by the bar, and the latter clasped to the legs of the pin.

3. A machine for crimping or ruffling textile fabrics has usually a pair of fluted rollers between which the article is passed, as in the illustration, in which are two fluted cylinders, the lower in fixed bearings, the upper vertically adjustable; one or both being hollow for the reception of a heated iron.

4. (*Wire-working.*) A machine in which wire is given a sinuous form, to adapt it the more readily to take its position in woven wire-work.

Fig. 1519.

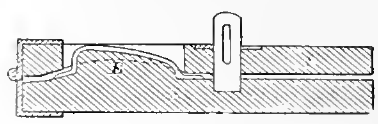


Wire-Cloth Crimper.

A machine in which wire cloth is crimped by pressure between dies, each of which has projecting teeth which come opposite the interdental spaces of the other die.

5. (*Saddlery.*) A press or break in which leather is molded into form between dies, as in the illustration, in which leather for a saddle-pad is placed on the bulbous portion *B*, and the hinged portion is brought down over it and locked in position till the leather is sufficiently dried to retain permanently its new shape.

Fig. 1520.



Pad-Crimp.

Crimp'ing-ma-chine'. See CRIMPER.

Crimp'ing-i'ron. An instrument for pinching, puckering, or fluting cap-fronts, frills, skirts, etc. See CRIMPER.

Crin'gle. (*Nautical.*) A rope made into a grommet and containing a thimble, and worked into the bolt-rope of a sail for the attachment of a bridle or other rope. The head-cringle is lashed by the head-earing to the strops on the yard-arm. The cringles on the leech are for the attachment of the *reef-tackle.*

Crin'o-line. (*Fabric.*) Originally, a horse-hair and cotton fabric for setting out a lady's skirts. The term is now commonly applied to the hoop-skirt, which has its periods of revival. Hoops were worn in 1740 three feet across the hips.

Crip'pler. A board with a corrugated under-surface and a strap above to hold it to the hand, used in *boarding* or *graining* leather, to give it a granular appearance and render it supple. The leather is folded with the grain side in contact, and rubbed on the flesh side with the *pommel*, which is another name for the *crippler.*

Crip'ple-tim'ber. Studding or scantling used in narrowing situations, where they are necessarily shorter than their fellows, as the *cripple-studding* from the rafters to the floor-joists in attics finished with a *collar-beam* ceiling. A *jack-timber.*

Crisp'er. An instrument for *crisping* the nap of cloth; *i. e.* covering the surface with little curls, such as with *petersham* or *chinchilla.* A *crisping-iron.*

Cris'tale. (*Fabric.*) A white worsted fabric.

Cro-chet'-lace. Hand-knitted lace.

Cro-chet'-nee'dle. A needle with a hooked end, used for catching the thread and drawing it through the loop in crochet-work.

Cro-chet'-type. Type with fancy faces, to set up in imitation of lace, crochet, or worsted work.

Crock'er-y-ware. See POTTERY; EARTHENWARE; PORCELAIN, etc.

Crock'et. (*Architecture.*) An upwardly projecting carved ornament on a Gothic gable or flying-buttress.

Cro'cus. A polishing powder composed of peroxide of iron. It is prepared from crystals of sulphate of iron, calcined in crucibles. The portion at the bottom, which has been exposed to the greatest heat, is the hardest, is purplish in color, and is called *crocus*. It is used for polishing brass or steel. The upper portion is of a scarlet color, and is called *rouge*. It is used for polishing gold, silver, and speculum metal. *Rouge*, the cosmetic, is made from safflower, or from carmine, which is a preparation of cochineal.

Croft'ing. Exposing linen on the grass to the influence of air and sunshine, after being *bucked* or soaked in an alkaline lye.

Cro-mor'na. (*Music.*) The *cromorna* or *krummhorn* is a reed-pipe stop of an organ, toned in unison with *open-diapason*, and depending for the peculiar *timbre* or quality of its tone upon the shape and proportions of the tube through which the sound of the tongue is emitted. See STOP.

Croom. A husbandman's fork with long tines.

Crop. (*Mining.*) 1. Tin ore of the first quality, after it is dressed or cleaned for smelting.

2. The appearance of a vein or seam, as of ore or coal, at the surface. The *strike*.

Cropped. (*Bookbinding.*) A book cut so severely as to reduce the margin too much. When cut into the print, the book is said to *bleed*.

Cross. 1. (*Telegraphy.*) Accidental metallic connection between two wires on a line. — POPE.

2. (*Surveying.*) An instrument for laying off lines perpendicular to the main course.

Cross-ax'le. 1. A shaft, windlass, or roller worked by opposite levers; as the copper-plate printing-press, etc.

2. (*Railroad Engineering.*) A driving-axle with cranks set at an angle of 90° with each other.

Cross-bar Shot. Shot which folds into a sphere for loading, but on parting from the muzzle expands to a cross with sections of the shot at the extremities of the arms.

Cross-beam. A beam in a frame laid crossways. In a ship, a piece laid across heavy posts called *bitts*, and to which the cable is fastened when riding at anchor.

Cross-bear'er. The transverse bars supporting the grate-bars of a furnace.

Cross-bond. A form of bricklaying in which the joints of one stretcher-course come in the middle of the courses above and below.

Cross-bow. A weapon formed of a bow crosswise upon a stock. It is similar in kind to, but smaller than, the ballista, which it doubtless suggested. It was used by the Normans at the battle of Hastings. The *arbalest* was a form of it.

Cross-chap Vise. A vise in which the jaws close towards each other in a line contrary to their usual direction.

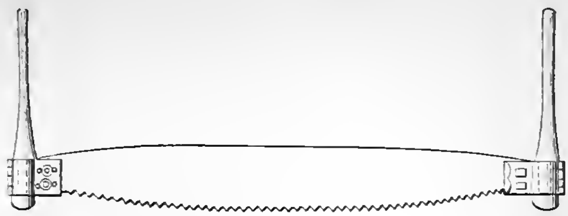
Cross-chock. (*Shipbuilding.*) A piece fayed across the dead-wood amidships, to make good the deficiencies of the lower futtocks.

Cross-course. (*Mining.*) A non-metalliferous seam crossing at right angles thereto.

Cross-cut. (*Mining.*) A drift from a shaft, to intersect a vein of ore.

Cross-cut Chis'el. A chisel with a narrow edge and considerable depth, used in cutting a groove in iron, especially in cast-iron, where a portion is to be cut or broken off.

Fig. 1521.

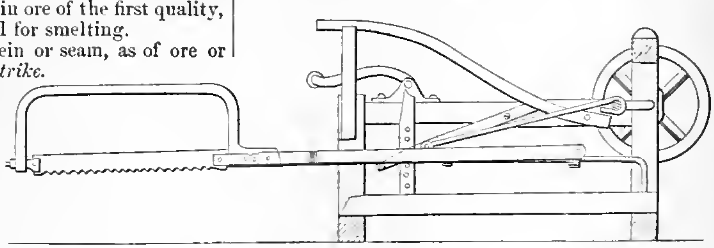


Cross-Cut Saw.

Cross-cut Saw. A saw adapted for cutting timber across the grain.

Hand-saws are made and set for the purpose. The ordinary saw for cutting timber into lengths has a handle at each end and cuts each way.

Fig. 1522.



Drag-Saw.

The *drag-saw* is for cross-cutting, but only cuts on the *pull* motion, being stocked at one end.

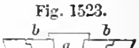
Crossed Belt. (*Machinery.*) A belt crossed between pulleys so as to revolve them in opposite directions. (See BELTING.) To prevent the rubbing of the belts, rollers may be interposed.

Crossed Lens. (*Optics.*) A form of single convex lens having the least spherical aberration. The refractive index of the glass should be 1.5, and the radius of the posterior surface six times that of the anterior surface, both surfaces being convex.

Crossed Out. When the web of a wheel is sawed and filed away so as to leave a cross of four spokes or arms, it is said to be crossed out. This is common in watch and clock wheels.

Cros-sette'. (*Building.*) A projecting piece on a *roussoir*, as *a b b*, which gives it a bearing upon the next *roussoir* on the side towards the *springing*.

Fig. 1523.



Crossette.

Cross-file. A file used in dressing out the arms or crosses of fine wheels. It has two convex faces of different curvatures. It is also known as a *double half-round* file.

Cross-frog. An arrangement of crossing rails at a rectangular intersection of roads. Each track is notched for the passage of the flanges of the wheels traversing the other track. A *crossing*.

Cross-gar'net. A cross-shaped hinge made like the letter T on its side (⊢). The cross-portion is fastened to the jamb or post, and the strap is hinged to the vertical leaf and secured to the door or gate.

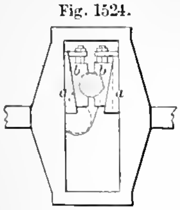
This is an ancient form, and many very elaborate examples are found in ecclesiastical and feudal architecture.

Cross Half-lat'tice I'ron. A kind of angle-iron with four radiating flanges. Double-T iron, with a section like a Greek cross.

Cross-han'dle. A handle attached transversely to the axis of the tool, as that of the auger. One form of dueling-pistols had a cross-handle.

Cross-head. (*Steam-engine.*) A bar moving between parallel and straight slides. It is driven by the piston-rod, and by means of a connecting-rod imparts motion to a beam, or to the crank of an axle or shaft. On its ends are the *cross-head blocks*, which slide between two parallel guides.

Fig. 1524.



Sliding Journal-Boxes.

The *sliding journal-box* (Fig. 1524) is adapted to occupy a slot in a cross-head to which it imparts motion. The box has two taper-cheeks *a a* and two taper-gibs *b b* adjustable by screws, so as to set up the boxing to the wrist and the cheeks to the guides in the cross-head.

Cross'ing. (*Railway.*) A casting placed at the rectangular intersection of two railways, where the rails of each track are partly cut away to allow passage to the flanges of the crossing wheels.

Cross-jack Yard. (*Nautical.*) *a.* The yard of a square-sail occasionally carried by a cutter in running before the wind.

b. The lower yard on the mizzen-mast.

Cross-lode. (*Mining.*) A cross-vein; one intersecting the principal lode.

Cross-mouth Chis'el. A boring-chisel of a cylindrical form with a diametrical blade.

Cross-pawl. See Cross-spall.

Cross-piece. (*Shipbuilding.*) *a.* A flooring-piece resting upon the *keel* and placed between the *half-floors* which form the lower sections of the *ribs* on each side. The *half-floors* make a butt-joint on the middle line of the vessel between the *keel* and *keelson.*

b. A bar running athwartship between the knight-heads, and to which the running rigging is belayed.

c. A bar connecting the bitt-heads.

Cross-rule Pa'per. Paper ruled off in squares, affording a means of drawing a pattern for weaving or worsted work.

Cross-shed. The upper shed of a gauze-loom.

Cross-sill. A railroad sleeper or tie lying transversely beneath the rails.

Cross-som'er. Or *summer.* A beam of timber.

Cross-spall. (*Shipbuilding.*) A temporary horizontal timber-brace, to hold a frame in position. Vertical or inclined braces are called *shores.*

Cross-spalls hold the position afterwards occupied by the *deck-beams.*

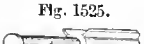
Cross-spring'er. (*Architecture.*) In a groined arch, the rib that springs from a pillar in a diagonal direction at the intersection of the arches forming the groin.

Cross-staff. A surveyor's instrument for measuring off-sets.

Cross-strain'ing. (*Saddlery.*) Canvas or webbing stretched transversely over the first *straining.* The two are stretched over the tree, and united form the foundation for the seat of the saddle.

Cross-tail. (*Steam-engine.*) A bar connecting the rear ends of the *side-bars* of a back-action steam-engine. The side-bars proceed from the cross-head on the end of the piston-rod, and receive motion from the piston; from the cross-tail proceeds the pitman, which is connected to the crank of the propeller-shaft.

Fig. 1525.



Cross-Tail Gudgeon.

Cross-tail Gud'geon. (*Machinery.*) A gudgeon having a winged or ribbed shank.

Cross-tie. (*Railroad Engineering.*) A cross-sill beneath the rails, to support them and keep them from spreading apart.

Cross-tim'ber. (*Shipbuilding.*) One of the *floor-timbers* of a frame, resting at its middle upon the *keel.* Butted against its *heads* are the *heels* of the *first futtocks.* Alongside of it are *half-floor timbers,* whose *heels* butt against each other over the *keel.*

Cross'-trees. (*Nautical.*) Timbers athwartship in the tops, resting on the trestle-trees, to spread the shrouds of the mast above and support the frame of the top.

Cross-vault'ing. (*Architecture.*) A ceiling formed by the intersection of two or more simple vaults of arch-work.

Cross-weav'ing Loom. A loom for weaving with a crossed warp.

Cross-web'bing. (*Saddlery.*) Webbing stretched transversely over the saddle-tree, to strengthen the foundation for the saddle-seat.

Cro'ta-lo. A Turkish musical instrument.

Cro'ta-lum. (*Music.*) An ancient castanet, used in the rites of Cybele.

Crotch. (*Nautical.*) A forked post for supporting a boom or horizontal spar.

Crotch'et. 1. (*Surgical.*) (Fr. *crochet,* a hook.) Applied to surgical and other instruments of a hooked form derived from the French; as the *craniotomy* or *placenta* hooks.

Specifically, a curved instrument for extracting the fetus.

2. (*Printing.*) A bracket ("[ ]").

3. (*Nautical.*) A forked support. A *crotch.*

4. (*Fortification.*) An indentation in a covered way, opposite to a traverse.

Croud. A crypt, or under-croft of a church.

Crow. 1. An iron bar used as a lever; it had usually a bent end, which was frequently forked, and may have been named from its fancied resemblance to a beak.

Fig. 1526.

Crows.

2. Formerly, the beak or rostrum on the stem of a war-galley. Also a device formerly used, consisting of a pivoted lever and chain with hooks for engaging an enemy's vessel or picking off her men. A *corvus.*

Crow-foot. 1. (*Nautical.*) A contrivance for suspending the ridge of an awning. It consists of a number of cords depending from a long block called an *euphroe* or *uphroe.*

2. (*Fortification.*) A *crow's-foot* or *caltrop.* See Caltrop.

Crowle. An old English wind-instrument.

Crown 1. (*Architecture.*) *a.* The vertex of an arch.

b. The *corona* or upper member of a cornice.

2. The dome of a furnace.

3. A size of paper, 15 × 19 inches.

4. The hub or canon of a bell.

5. The upper surface of a hat body.

6. An English silver coin; value, 5 shillings.

7. The part of a cut gem above the girdle.

8. The part of an anchor where the arms join the shank.

9. The steel face of an anvil.

Crown-gate. The head-gate of a canal-lock.

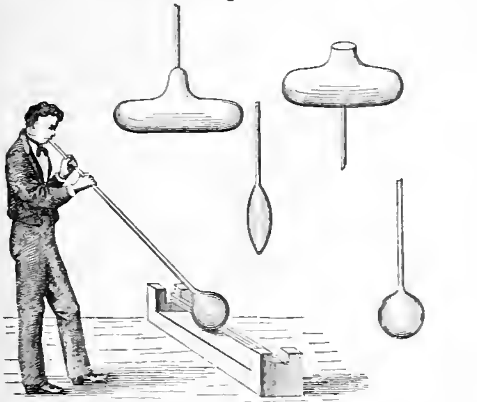
Crown-glass. Glass made by blowing and whirling, changing the ball of glass into a globe and eventually into a disk attached to the end of the *ponty.* Window-glass is made in this manner. Crown-glass is a finer variety, a compound of silicate of potash, or soda, and silicate of lime, — silica, 63 ; potash, 22 ; lime, 12 ; alumina, 3. It is much harder than the glass into whose composition lead enters, and which is called *flint*-glass.

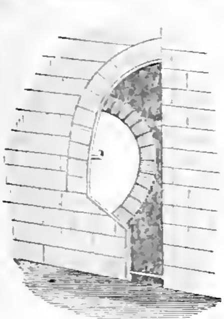
Bohemian glass, in its composition, is similar to the above in respect to the absence of lead in notable quantities. It is a silicate of potash and lime, with a little silicate of alumina. It is very hard, transparent, and difficult to fuse.

Crown-glass is made in round disks by the following process : —

The materials are fritted in a reverberatory furnace, and then melted in a pot. A lump of glass sufficient to make a *table* of nine pounds weight is extracted at the end of a *blowing-tube*, and is distended into a pear shape by blowing through the tube and rolling on the *marver*, which is a cast-iron slab on a stand. Being softened by heat at the mouth of a small blowing-furnace, it is rolled on the *marver* and blown till it assumes a more spherical shape, but has a conical end, which is removed as the glass approximates a spherical form, being blown as it is rolled on the *bullion-bar*. Being again heated at the blowing-furnace, rotation and blowing being persevered in, it becomes spherical. It is then presented at a larger furnace-hole called the *bottoming-hole*, and being rapidly rotated becomes oblate. A *pontil* tipped with molten glass is then applied to the center of the flat portion, and the blowing-tube is detached by touching the neck of the globe with a cold wet iron. This leaves a hole in the end from which the blowing-tube was detached, and the article appears as shown at the right-hand upper corner.

Fig. 1527.





Glass-blowing.

Heat and rotation being still applied, first at a furnace-opening of moderate size called the *nose-hole*, and then at a much larger one called a FLASHING-FURNACE (which see), the hole becomes more and more enlarged as the article becomes more and more oblate. Finally it flies open with a sharp rustling noise, and appears as a flat plate, called a *table*, adhering at its central, thicker portion, the *bull's-eye*, to the *pontil*, by which, during the later portions of the process, it was rested on the hook in the half-wall before the furnace, which formed a partial screen for the workman.

When it has cooled sufficiently to be rigid and not liable to bend or collapse, it is placed on a fork, the *pontil* detached by the application of a cold iron, and the *table* placed in the annealing arch or kiln, where it rests on its edge for perhaps twenty-four hours, gradually cooling. The annealing-arch is termed a *leer*, and this is often made continuous ; the trays holding the ware traveling from the hot to the cool end, being pushed along as the trays of recently made glass-ware are received at one end, while the contents of the trays at the discharge-end, having cooled sufficiently to bear handling, are removed.

The size of a *table* or disk of crown-glass is about 52 inches, and a pot holding one half-ton will make about 100 tables.

Crown'ing. 1. (*Machinery.*) The central bulge or swell of a band-pulley.

2. Convex at top ; opposed to *dishing*.

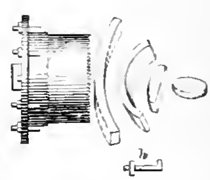
Crown-pa'per. Paper which formerly had the crown for a water-mark. Its size is 15 × 19 inches.

Crown-piece. A strap in a bridle, head-stall, or halter, which passes over the head of a horse, its ends being buckled to the cheek-straps.

Crown-post. (*Carpentry.*) A vertical post in a truss, supporting the crown-plate in a *king-post truss*. A *king-post*.

Crown-saw. A saw of cylindrical shape, with teeth on the end and operated by a rotative motion. The *trephine* was the first of the class. It is used for making buttons and markers, sawing staves, brush-backs, chair-backs, etc.

Fig. 1528.

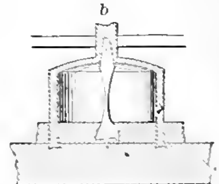


Crown-Saw.

Crown-saws of large size are made in sections, riveted to the outside of a strong ring, and carefully hammered, so that the plates constitute one continuous cylinder ; the edges of the plates making butt-joints with each other. The ring is fixed to the surface-chuck of a lathe-mandrel, by means of hook-bolts *h*, and the work is grasped in a slide-rest, which traverses within the saw and parallel with its axis.

Smaller cylindrical saws are made of a single, bent steel plate, rolled to form, and brazed at the joint. They are used in barrel-making machines, to saw staves from the bolt.

Fig. 1529.



Sheave-Saw.

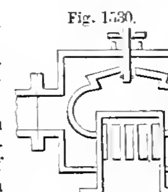
Fig. 1529 shows a crown-saw and bit by which the sheaves for blocks are cut out and bored simultaneously ; *b* is the stock to which the cylindrical saw and the center-bit are attached.

Crown-sheet. The upper plate of a locomotive fire-box.

Crown-tile. A common, flat tile. A *plane-tile*.

Crown-valve. A dome-shaped valve which is vertically reciprocated over a slotted box.

Fig. 1530.



Crown-Valve.

Crown-wheel. One in which the cogs are perpendicular to the plane of motion of the wheel. It is also called a *contrate* or *face* wheel. *Contrate* is a term applied to this wheel in horology. *Face*-wheel indicates that the teeth project from the circular face, as distinguished from the periphery or rim.

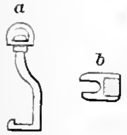
Crown-wheel Es-cape'ment. One so named because the escape-wheel is a crown ratchet-wheel whose teeth escape from the pallets of the verge. A *vertical escapement.*

Crown-work. (*Fortification.*) An extension of the main work consisting of a *bastion* between two *curtains*, which are terminated by *half-bastions* and commanded by the main-work.

Crow's-bill. (*Surgical.*) A bullet forceps.

Crow's-foot. 1. (*Well-boring.*) A bent hook adapted to engage the shoulder or collar on a drill-rod or well-tube while lowering it into a well or drilled shaft, or to hold the same while a section above it is being attached or detached (*a*, *b*, Fig. 1531).

Fig. 1531.



Crow's-Foot.

In well-boring the auger or drill-rod passes through a hole in the staging, but the crow's-foot is too large to pass through the hole, and is thus the means of holding the sections of rod or tubing which are suspended therefrom.

A *scotch* answers the same purpose. It is a bent bar which slips on the rod and forms a resting-place for the shoulder or collar.

2. (*Fortification.*) A ball armed with spikes, so arranged that one is always presented upwardly; such are strewn on the ground for defence against the approach of cavalry. A *caltrop.*

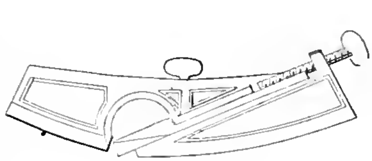
Crow's-nest. A tub or box at the top-gallant mast-head, for the lookout-man who watches for whales.

Croy. A mound or structure projecting into a stream, to break the force of the water on a particular part and prevent encroachments.

Croze. 1. (*Coopering.*) A tool used for making the grooves for the heads of casks, after the ends of the staves have been leveled by a tool called a *sun-plane*, which is like a *jack-plane*, but of a circular plan.

The *croze* resembles a *gage*, except that it is very much larger; the head is nearly semicircular, and terminates in two handles. The stem, which is proportionally large, is secured by a wedge; the cutter is composed of three or four saw-teeth, closely followed by a hooked router, which sweeps out the bottom of the groove.

Fig. 1532.



Cooper's Croze.

In another form, it is a circular plane with a gouge-bit.

2. (*Hat-making.*) To unroll and re-roll a hat-body so as to change the surfaces in contact, and prevent their felting together in the process of felting hats.

Croz'ing-ma-chine'. (*Coopering.*) A machine for cutting on staves the croze or groove for the reception of the edge of the head.

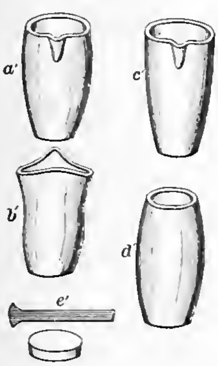
Cru'ci-ble. 1. A melting-pot of an earthen composition or of refractory metal, adapted to withstand high temperatures. They are mentioned by the Greek authors, and are shown in the ancient Egyptian paintings, and were early used in docimastic operations, and were made by the old alchemists for their own use. Metallic crucibles are of platinum, silver, or iron. See Faraday's "Chemical Manipulations."

Agricola, the celebrated metallurgist, and Glauber, a noted chemist, both in the sixteenth century, made their own crucibles.

Hessian crucibles are made of the best fire-clay and coarse sand. They are the cheapest, and answer for all uses where a single melting will suffice, as in refining or experiments. They come in nests of sizes from two inches up to eight inches high. They are used in this country in all experiments where fluxes are needed; are round at the bottom, but are furnished both round and triangular at the top. Wedgwood made crucibles in his time of a close and fine texture, but liable to crack. In France an excellent crucible is made at Picardy of a sort of kaolin and fine sand. They are made very thin, turned up on a potter's wheel; are tall and slim, bend easily at a high heat, and are liable to crack in cooling, but are used largely by the melters of bronze and brass in Paris. The Dutch made what were known as "blue pots," or "black-lead pots" of clay and graphite in the early part of the seventeenth century; and in their day these were the safest melting-pots, because they would stand four or five meltings, and submit to considerable change of temperature, before cracking. The graphite was known by them as *pot loot*, or potter's lead, from the use of it. In England many kinds of clay were used; but the chief dependence was on that known as the "Stourbridge clay," which, when mixed with pulverized coke, made a useful and cheap melting-pot, but it could not be cooled off and used again. In 1827 the late Mr. Joseph Dixon began the manufacture of crucibles by mixing the graphite, otherwise known as plumbago, found in the State of New Hampshire, with a clay used by the glass-makers, for melting-pots; and these were much better than the Dutch pots, being able to stand very great and sudden changes of temperature. Mr. Dixon saw beautiful specimens of foliated graphite, brought home as curiosities by the captains of India ships that had touched at Ceylon; and, finding this better than the New Hampshire graphite, he procured a shipment in 1828, being the first lot of Ceylon graphite ever brought to the United States, and the first known use of foliated graphite for crucible making. About 1830 Mr. Dixon adopted the "Dutch pipe-clay" to mix with the Ceylon graphite. To ten pounds of ground graphite, seven pounds of clay, two pounds of fine kaolin, and one pound of fine quartz sand, add water, to make the mass plastic enough to be turned up on a potter's wheel to the desired shape. To the above, for steel melting, there should be added half a pound of pulverized charcoal or coke, as may be most convenient. The pots are dried carefully, burned in a potter's kiln to a white heat, and are then fit for use. In use, crucibles should be placed in the fire, and not on it. The fire should surround the crucible to the very top, and a blast, if used, should not strike the crucibles direct. They should be kept in a dry place, the least dampness being fatal. If they are well made, no annealing is needed, the object of annealing being only to complete the shrinkage that should be fully accomplished in the "burning" by the crucible-maker. For melting brass, copper, gold, silver, or alloys of metals, a Dixon graphite crucible should run from twenty to forty meltings, according to the fuel, draft, care, or other circumstances. For melting steel they will run from four to six times, and longer by a systematic cleaning the slag from the surface after each melting, and coating the crucible with a mixture consisting of fire-clay, graphite, charcoal, and pure fine quartz sand. In handling crucibles the tongs should fit so as not to bend them in lifting from the fire, as the frequent bending will crack the crucibles before they are worn out.

Crucibles are made at the Dixon Works, Jersey City, New Jersey, of all sizes, from those that hold but two ounces up to six hundred pounds capacity. Covers are made for all sizes. Retorts of all shapes and chemical ware are also made of the crucible mixture. It will stand a very high heat, but is wasted by most fluxes. At the mints large crucibles are used, and *dippers* are made of the same material, with which the metal is ladled out. *Stirrers* are also made with which to stir up the liquid metal. The crucibles are sized by figures denoting the number of kilogrammes of brass they will hold, No. 1 holding $2\frac{1}{3}$ pounds, No. 10 holding 22 pounds, and so on up to No. 300. See GRAPHITE.

Fig. 1533.



Crucibles.

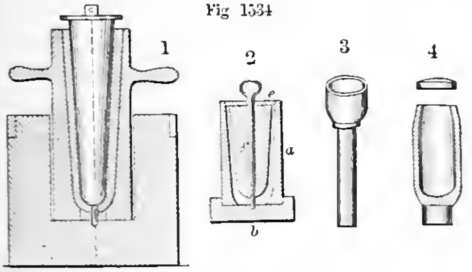
Crucibles for glass-makers are made of a mixture of burned fire-clay very coarsely ground, with the raw clay and a portion of the old pots ground up.

Several forms of melting-pots are shown in Fig. 1533. *a* and *b'* are refiners' pots for gold and silver; *c'*, a foundry-pot; *d*, a steel pot; *e'*, crucible lid and stirrer of the same intractable material.

2. A basin at the bottom of a furnace to collect the molten metal.

Cru'ci-ble-mold. Crucibles are molded on a wheel or in a press. Different materials, qualities, and sizes require different treatment. One common ordinary mode of forming crucibles for melting steel, in the process of making, is shown in Fig. 1534, 1

Fig 1534

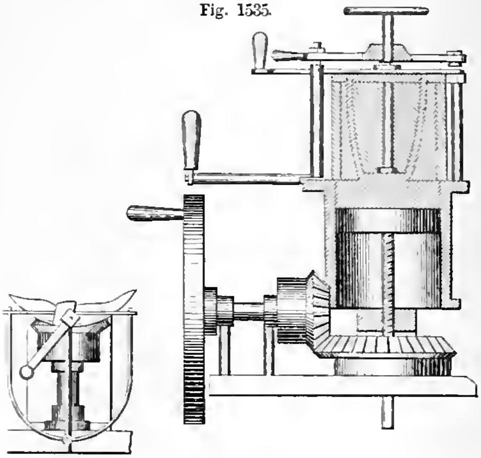


Crucible-Mold.

and 2, which show the cast-iron mold with a hard-wood core; the larger illustration shows a mold with handles for lifting. The lump of clay is placed in the mold *a*, the core *c* is forced down upon it, and driven down by a hammer until the rod in the center enters the hole in the bottom *b* of the mold. *c* is the circular plate which molds the upper edge. In removing, the core *c* is first carefully lifted and the hole in the bottom closed by a plug of clay. The mold *a* is then lifted from the bottom *b* and placed on the post shown at 3; the top of this is somewhat smaller than the opening in the bottom of the mold, which is then pressed carefully downward, leaving the molded crucible on the top of the post. The upper margin of the crucible is then pressed in by hand, assuming the form represented at 4; the circular cover and cylindrical stand-piece being also shown.

Fig. 1535 shows a form of press for molding crucibles, in which the piston forces the clay from the

Fig. 1535.

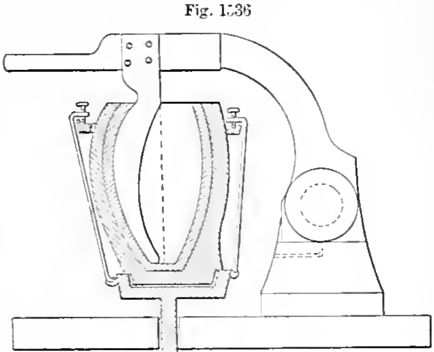


Crucible Molding-Press.

cylinder into the mold above. The bottom of the mold corresponds to the base of the crucible, and the core is held in place by a locking-plate above. The clay in the mold is cut off from the mass by a wire which runs between the cylinder and the mold.

In the molding of crucibles on a throwing-table the latter has a rim-base for the mold, and is rotated by power applied beneath. The plaster-of-paris mold has a detachable bottom, and its circular body is divisible vertically into two halves secured by a hoop. The mass of material, being placed in the

Fig. 1536



Crucible-Molding.

mold, is fashioned by a hinged molding-blade, which corresponds in shape to the inner surface of the intended crucible, and by pressure builds up the plastic material against the inside surface of the mold. The surplus material at top is cut off with a knife. The blade is withdrawn, and the crucible, with its mold, is removed to dry and harden, previous to burning.

One other mode of molding is sometimes practiced:

the slip, of the consistence of cream, is poured into molds made of stucco, and allowed to stand in the mold until a sufficient quantity will adhere to the mold, when the remaining liquid portion is poured out. The mold and its inner coating of *slip* are removed to the oven, when the slip contracts and may be removed. When dry, the biscuit crucible is ready for baking.

Fig. 1537.

Crucible-Tongs.

Cru'ci-ble-ov'en. A heater for crucibles, to dry them before burning in a kiln. Plastic clay is molded into *green* crucibles, assumes the *biscuit* form by drying, and is *burned* to constitute a crucible.

Cru'ci-ble-tongs. A form of tongs for lifting crucibles from the furnace.

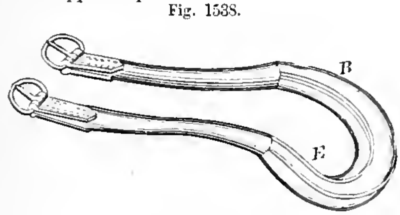
Cru'et. A jar or bottle for condiments or flavors used at table upon meats, etc. A *caster.* A *cruet-stand* holds a number of such little vials.

Cruive. A salmon-trap of the nature of a weir. It has stone walls, which cross the river, and an intermediate chamber of slats or spars which admit the fish but oppose their exit.

Crumb-re-mov'er. A tray for receiving the crumbs swept up by the crumb-brush.

Crup'per. (*Harness.*) A loop which passes beneath the tail of a horse, and is connected by a strap with the saddle, to keep it from riding forward. The rounded portion *E B* is the *crupper-loop.*

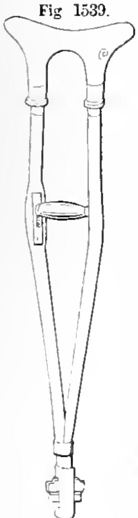
Fig. 1538.



Crupper.

Crup'per-chain. (*Nautical.*) A chain for lashing the jib-boom down to the bowsprit.

Fig 1539.



Crutch.

Crush'er. A mill or machine for mashing rock or ore. See ORE-CRUSHER; STONE-CRUSHER; STAMP.

Crutch. 1. A staff with a cross-piece to support the person beneath the arm-pit. The foot is shod with a rubber pad, or may have a spur to prevent slipping.

2. (*Horology.*) The fork at the end of the arm which depends from the axis of the anchor-escapement. The pendulum-rod is contained within the limbs of the *crutch*, and vibrates the anchor, itself also receiving a slight impulse from the train.

3. (*Saddlery.*) One form of pommel for a lady's saddle, consisting of a forked rest which holds the leg of the rider.

4. (*Shipwrighting.*) *a.* One of the struts or stay-plates in the prow or stern of an iron vessel, which supports the sides where they nearly approach each other. They occupy a position corresponding to that of the *dead-wood* in a timber vessel, and are used to prevent the crushing in of the plating.

b. A knee-timber placed inside a vessel to secure the heels of the cant-timbers abaft.

c. A support upon the taffrail for the boom.

d. A forked row-lock upon the gunwale.

5. (*Founding.*) The cross-handle on the end of a *shank*, (a founder's metal-ladle,) by which it is tipped.

Crwth. A Welsh musical instrument with six strings, played upon with a bow.

The first four strings are conducted from the tail-piece down the finger-board; but the fifth and sixth, which are about an inch longer than the others, branch from them laterally, and range about the distance of an inch from the neck.

Cry'o-lite-glass. A semi-transparent glass made from cryolite and sand, and sometimes known as *fusible porcelain* or *milk-glass.*

Cry-oph'o-rus. An instrument to illustrate the process of freezing by evaporation. Invented by Dr. Wollaston.

It consists of two bulbs and a connecting tube, air being expelled from the interior by heating the body of water inclosed and hermetically closing the opening. The water being poured into one bulb, the other bulb is placed in a mixture of ice and salt, which condenses the vapor and causes so rapid evaporation from the former bulb as to freeze the water therein.

Fig 1540.

Cryophorus.

Crypt. (*Masonry.*) A vault beneath a church or mausoleum, and either entirely or partly underground.

Cryp'to-graph. A message written in cipher.

Crys'tal. (*Glass.*) A peculiarly pellucid kind of glass.

Crys'tal-lized Tin-plate. Or *moire-métallique.* A variegated crystallized appearance produced on the surface of tin-plate by applying to it in a heated state some dilute nitro-muriatic acid, washing it, drying, and coating it with lacquer.

Crys-tal'lo-ce-ram'ic. A kind of glass incrustation. It consists of an opaque substance, imbedded in a mass of colorless glass. A medallion or bas-relief is molded in a peculiar kind of clay, and inclosed between two pieces of soft glass in their melted state. The molten glass is dropped upon the surface of the medallion, and the surface afterwards polished. The white clay seen within the clean and highly refractive glass presents an appearance nearly resembling that of unburnished silver.

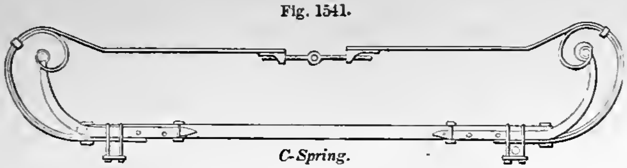
Crys-tal'lo-en-grav'ing. A mode of ornamenting glass-ware by taking impressions from intaglio, and impressing them on the ware while casting.

The die is first sprinkled over with Tripoli powder, then with fine dry plaster and brick-dust, and then with coarse powder of the same two materials; it is placed under a press, and at the same time exposed to the action of water, by which the sandy layers become solidified into a cast. This cast thus obtained is placed in the iron mold in which the glass vessel is to be made, and becomes an integral part of the vessel so produced; but by the application of a little water the cast is separated, and leaves an intaglio impression upon the glass as sharp as the original die. The cake thus used seldom suffices for a second impression.

Crys-tal'lo-type. A photographic picture on glass.

C-spring. (*Vehicles.*) A spring, in form like the letter C, and employed in close carriages of old style, and some modern ones. It is planted on the frame of the carriage, and to its upper pliable end the suspension-straps are fastened.

Fig. 1541.



C-Spring.

Cube Su'gar-ma-chine'. A machine for cutting up loaf-sugar into little cubes for table use consists of a set of circular saws which reduce it to the form of long square sticks. These are dropped into upright grooves in the machine, of which there are a number side by side, and of which the bottoms are removable plates. These form stops, and at the regulated distance above are a pair of knife-edges which move inward toward each other and divide all the columns of sugar simultaneously. As the knife-edges close, the supporting-plates open and allow the cubes to drop.

Cuck'oo-clock. One in which the hours are sounded by wind proceeding through reeds which simulate the voice of the bird after which it is named.

Cuck'old's-neck. A knot by which a rope is secured to a spar, the two parts of the rope crossing each other and seized together.

Cu-cur'bit. An earthen or glass vessel used in distillation, and having a rounded shape like a gourd; hence the name. It contains the liquid to be distilled, and is crowned by the *alembic*. See ALEMBIC.

Cu'cur-bit'u-la. A cupping-glass.

The *cucurbitula cruenta* is designed to draw blood.

The *cucurbitula sicca* is for dry cupping, and is a local vacuum-apparatus.

The *cucurbitula cum ferro* is armed with iron.

Cud'dy. 1. (*Nautical.*) *a.* The cook-house or galley of a vessel.

b. A small double-decked portion of a canal-boat or lighter, forming a cabin for the crew.

2. A lever mounted on a tripod for lifting stones, leveling up railroad-ties, etc. A *lever-jack.*

Cue. A staff with whose end the billiard ball is struck. It is usually shod with vulcanite or leather. This end is known as the *tip*.

Cui-rass'. An armor for the body; formerly of leather, but now of metal. It consists of a breast and a back plate, lapping on the shoulders and buckled together beneath the arms.

It succeeded the *hauberk*, or coat-of-mail, and the *hacqueton*, or padded leather jacket, about 1350. It has survived all other forms of defensive armor for the body, being yet in use in the heavy cavalry of some European armies.

The *surcoat* or *jupon*, which usually covered the former styles of armor, was laid aside about the time the cuirass was adopted, say the reign of Edward III.

The early cuirass of the Greeks was of linen, which was afterwards covered with plates of horn or scales of horse-hoofs.

The Roxalani wore leather with thin plates of iron. The Persians wore a similar cuirass. The Romans introduced flexible bands of steel, folding over one another during the flexure of the body.

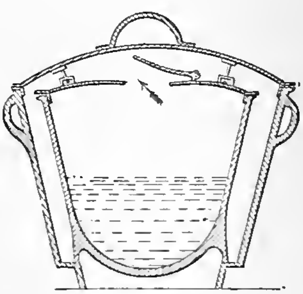
The Roman *hastati* wore chain-mail (*hauberks*). The same nation, as well as the Greeks, used the back and breast plate.

Cuisse. Plate-armor for the thigh. *Cuish; cuissot; cuissart.*

Cu-lasse'. (*Diamond-cutting.*) The lower, faceted portion of a brilliant-cut diamond, which is imbedded in the setting, or is below the girdle. The culasse has twenty-four facets, which occupy the zone between the girdle and the *collet* or *culet*. See BRILLIANT.

Cu'li-na-ry-boil'er. A cooking-vessel for holding water in which victuals are boiled. Its form and appurtenances are adapted to the customary uses of peoples,— to be swung over a fire, stand on a hearth, rest on the bars of a grate, set within a pot-hole of a stove. In Fig. 1542, the kettle is placed in an open-bottomed shell of similar shape, but of size sufficient to allow the caloric current circulation between them. A valve in the kettle-lid allows escape of steam beneath the lid of the shell.

Fig. 1542.

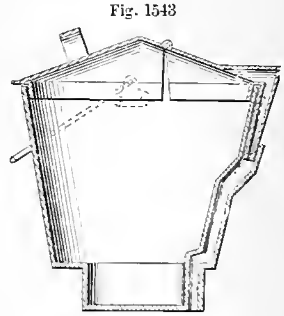


Culinary-Boiler.

Another form has a duct for leading off steam and effluvia. The lid has a hinged portion with a spout which conducts the steam to a pipe which leads it to the fire-chamber.

The boilers of nations unacquainted with metal or pottery were usually plaited vessels of roots or rushes so closely worked as to be water-proof, or treated with some water-resisting substance. The latter varied with different nations and tribes, according to the materials at hand.

Fig. 1543



Boiler.

Some of the North American Indians made their boilers of long, tough roots wound in plies around a center, and shaped like an inverted beehive. The water in all such vessels was heated by the introduction of hot stones from a fire kindled on the ground in the vicinity.

"If the Scythians do not happen to possess a caldron, they make the animal's paunch hold the flesh, and, pouring in at the same time a little water, lay the bones under and light them. . . . . By this plan your ox is made to boil himself." — HERODOTUS, IV. 61.

The Dacotah Indians sometimes boil animals in their own skins, taking the skin off whole, suspending it at the four corners, and making use of boiling-stones as usual.

The plan was commonly used in the stone age of Europe, and, no doubt, of other regions. The "boiling-stones" are familiar objects with archæologists, and are found with flint tools and weapons.

Several tribes of Polynesia and Oceanica have been discovered entirely destitute of any knowledge of boiling water. It occasioned the most intense wonder. Says Wallis: —

"It is impossible to describe the astonishment expressed by the Society Islanders when they saw the gunner dress his pork and poultry by boiling them in a pot. Having no vessel that would bear the fire, they had no idea of hot water."

Captain Cook says they had but two modes of cooking, — broiling and baking.

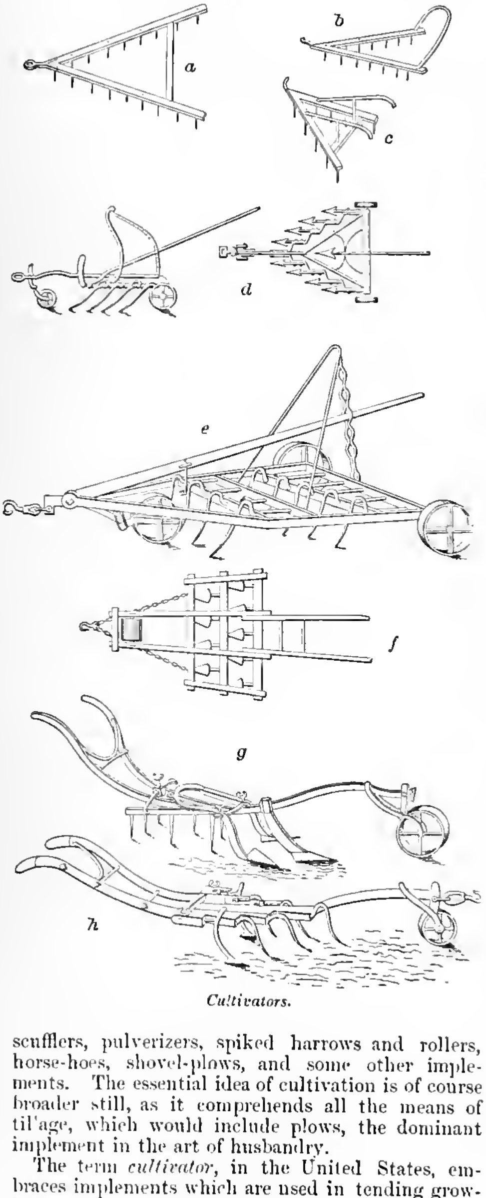
Cul'let. 1. A small central plane in the back of a cut gem.

2. (*Glass.*) Broken glass for remelting.

Cul'lis. A gutter in a roof or elsewhere.

Cul'ti-va'tor. This term, in a broad signification, includes harrows, drags, grubbers, scarifiers,

Fig 1544.



Cultivators.

scufflers, pulverizers, spiked harrows and rollers, horse-hoes, shovel-plows, and some other implements. The essential idea of cultivation is of course broader still, as it comprehends all the means of tillage, which would include plows, the dominant implement in the art of husbandry.

The term *cultivator*, in the United States, embraces implements which are used in tending growing crops. These are : —

1. The implement specifically known as a *cultivator*, having a triangular frame set with teeth or shares, and drawn by one horse, which walks in the balk between the rows of corn, potatoes, or other plants. The animal is hitched to the apex of the frame, and the implement is guided by a pair of handles at the rear.

2. *Single* and *double shovel-plows*, which are used for precisely the same purpose, but are known as plows. See SHOVEL-PLOW.

The cultivator is an improved harrow.

The course of improvement is not difficult for a farming mechanic to imagine.

The ordinary harrow, we may say, is dependent for its course solely upon the direction of draft.

A good harrow, especially for new ground and in fields where there are occasional obstructions, is that of an **A** form (*a*, Fig. 1544). The rear corners may be readily raised by a hooked stick, so as to allow it to pass a stump without swerving the team. Better still is a bow of hickory, as in the next figure (*b*) ; by this it may be lifted one side at once, or, by swinging back on it, the whole harrow is lifted, to clear it of accumulated weeds, etc. This harrow is for regular service in putting in crops.

A smaller size, with a bow handle, is made to go between two rows of corn, potatoes, beans, etc., the handle affording the means of swaying it towards or from the row, to suit any irregularity in the line of plants, and also to keep it to its duty if the horse swerves from the exact path.

Another mode of affixing handles is shown in the next figure (*c*), and this brings the subject to such close relationship to the cultivator as to render it unnecessary to trace the steps farther.

In connection with the subject we must not forget the author of "Horse-hoeing Husbandry." Jethro Tull introduced his system of drilling crops in 1701, with the object of cultivating the plants by machinery. He published his book 1731. His system rendered the cultivator possible.

The English cultivators and horse-hoes may be classed together, as no line of demarcation exists between them. The horse-hoes are designed to tend *drilled* crops, the prongs or shares passing along the balks between the rows of plants,— wheat, barley, oats, rye, turnips, beans, etc. This renders it necessary that the shares should have the same gage of width as the drills ; but this is all that is peculiar about them, and is a question of proportion, not principle.

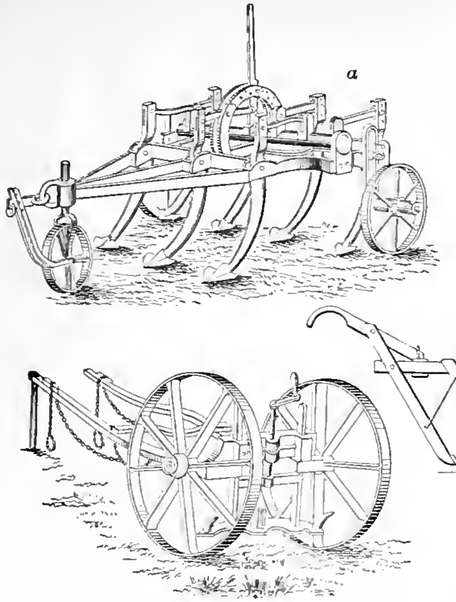
The tendency in all economical farming on an extended scale is toward reducing manual labor. Cultivators and shovel-plows have to a great extent superseded the hoe in corn-culture, and the English *horse-hoe* is designed to do the same in the culture of smaller drilled grain. A man can kill more weeds in a day with a double-shovel plow or cultivator than he can in a week with a hoe, *cæteris paribus.*

Wilkie, of Teddington, Scotland, is the inventor of the cultivator. He invented the plurality of shares, the expanding frame, and the caster-wheel. His cultivator (shown at *d*, Fig. 1544) has a frame of triangular form. The apex is supported on a caster-wheel, and the rear of the frame upon a pair of wheels. The share-frame is so suspended from the traction-frame as by a parallel movement to be raised bodily, or lowered, by means of a single lever projecting at the rear. The lever catches in notches in the segment-bar, so as to maintain the desired adjustment.

The teeth are curved prongs which enter the soil obliquely and raise weeds to the surface ; the trash passes up the incline, and falls over the rear ends of the teeth, which are thus self-cleaning.

Finlayson's cultivator *e* (British, 1826) is made of iron, and the prongs are arranged on parallel,

Fig. 1545.



English Cultivators

transverse bars of the frame, which is supported on a caster-wheel in front and two wheels at the rear. The depth of tilth is regulated by a lever, which is connected to the carriage of the caster-wheel so as to raise the apex of the frame when the lever is depressed, and conversely. The regulation for depth at the rear end is by set screws. The prongs are self-cleaning, having the arched form of Wilkie's; the rear set split the balks left by those preceding.

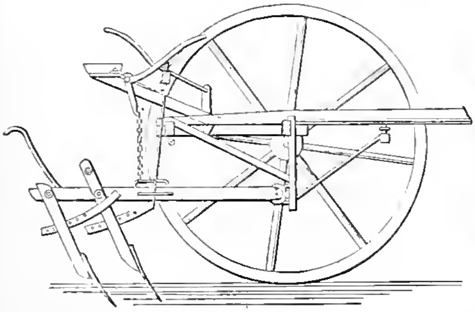
Finlayson's cultivator is shown at *f*.

Wilkie's horse-hoe and drill-harrow *g* (Scotland, 1820) has a central fixed share and adjustable side shares, which are expanded or contracted according to the state of the crop or the width of the balk. Following the shares is a frame with harrow-teeth. Either the share or the harrow-teeth may be removed, and the remainder used separately. The depth is adjusted by the caster-wheel in front.

h shows another form, somewhat modified.

In Fig. 1545, *a* is Colman's cultivator, and that below it is known as a skim-cultivator, with a long, curved, flat share, whose depth is regulated by a crank and screw.

Fig. 1546.

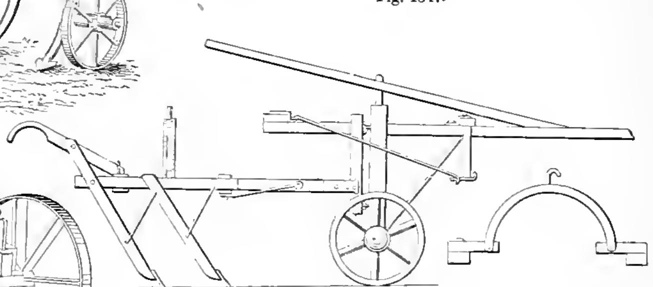


Cultivator

Fig. 1546 shows one American form of cultivator, in which the plows are managed by levers in driving and riding, and by the handles when walking behind the machine. The plow-beams are gimbal-jointed to standards depending from the axle, and have vertical and lateral movement by two hand-levers.

Fig. 1547 shows a form in which the plow-frames are attached by an arched yoke, which permits independent motion. Their clevises embrace posts shackled to the carriage.

Fig. 1547.



Cultivator.

Cul'ti-va'tor-plow. A plow used in tending crops, such as *shovel-plow*, a *double shovel-plow*, etc. See CULTIVATOR.

Cul've-rin. (*Ordnance.*) A cannon of the sixteenth century; from 9 to 12 feet long, 5½ inches bore, and carrying 18-pound round-shot. A demi-culverin was a 9-pounder.

Cannon in those times were named after reptiles and rapacious animals; as, for instance, —

Culverin (*couleuvrine*, Fr.), serpent, from the snake (*coluber*), which was formed upon it to constitute handles.

Musket (*mosquet*, Fr.), sparrow-hawk.

Dragon (Fr.) was the name of a certain form of *musquet*, and survives in the word *dragoon*.

Falcon was an ancient name of a certain grade of ordnance.

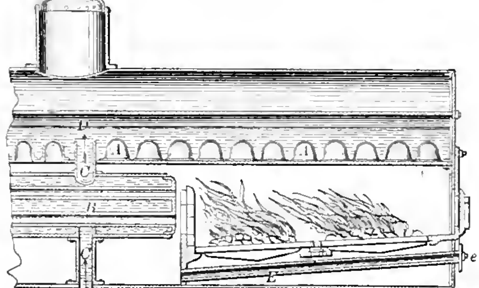
Cul'vert. A drain or water-way of masonry beneath a road or canal. It is a bridge or viaduct on a small scale.

Cul'ver-tailed. Dovetailed. (*Culver*, Anglo-Saxon, pigeon.)

Cum'ming. (*Brewing.*) A vessel for holding wort.

Cu-nette'. (*Fortification.*) A small ditch in the middle of a dry ditch, to drain the water off the place.

Fig. 1548.



Cup-Surfaced Boiler.

Cup. 1. The step of the capstan-spindle.

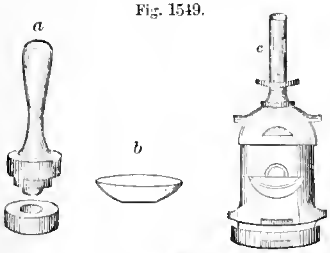
2. A hollowed portion or object, to hold a liquid.

3. A glass placed above a scarified place, to extract blood in cupping.

4. One of a series of little domes (*A*) attached to a boiler-plate and serving to extend the fire-surface. In Fig. 1548 the device is shown as attached to a Cornish-boiler, the cups projecting into the water, and tubes *B* passing through the water-chamber. *C* are pipes connecting the jacket on the interior water-space. *D*, the outer water-space. *E*, passage to admit air to the fire-bridge. *c*, air-induction valve.

Cu'pel. A porous vessel, usually made of pulverized bone-ashes, and employed in assaying for separating the precious metals from their oxydizable alloys. Cupels are made in a mold with a die having a boss-like projection for forming the cavity for containing the specimens to be assayed. Those used in the British mint are made of the cores of ox-horns burned and pulverized.

Fig. 1549.



Cupel-Mold.

Cupels of bone earth are described by the great Arabian chemist Djafar, who lived about A. D. 875. He was the discoverer of nitric acid and aqua-regia. See ALEMBIC.

Cu'pel-la'tion. An alloy of silver and lead is exposed to a red heat on the floor of a muffle, where a current of air plays over its surface. The lead is converted into the protoxide, melts, and runs off, leaving the *refined silver*.

In assaying silver it is purified in a small cupel subjected to an oxydizing heated blast. This leaves it *pure* silver, the lead passing into the porous vessel.

The assay of gold is more complex. The copper and other oxydizable metals are removed by cupellation with lead. A large excess of silver is then added to the alloy, which is rolled into a sheet called a *cornet*. The silver is dissolved out with nitric acid, which leaves the gold as a *sponge*. This is called *parting*.

The process of refining silver with lead in a furnace is described by Ezekiel, and is regarded by Napier as substantially coincident with the modern cupellation.

Cu'pel-lo. A small furnace for assaying.

Cu'pel Py-rom'e-ter. An alloy pyrometer which indicates the heat by incipient or total liquefaction.

Cu'po-la. 1. (*Architecture.*) *a.* A lantern or small apartment on the summit of a dome.

b. A spherical or spheroidal covering to a building or any part of it.

2. (*Metallurgy.*) *a.* A furnace for melting metals for casting. See CUPOLA-FURNACE.

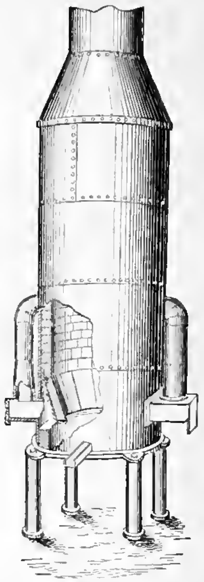
b. A furnace for heating shot to be fired at shipping and other inflammable objects.

Cu'po-la-fur'nace. A furnace for melting iron in a foundry.

The name is derived from a cupola or dome leading to the chimney, which is now frequently omitted. A cupola of ordinary size may be thus described: —

At the base is a pedestal of brickwork 20 to 30 inches high, upon which stands a cast-iron cylinder from 30 to 40 inches diameter, and 5 to 8 feet high; this is lined with fire-clay, brick, or other refractory matter, which contracts its internal diameter to from 18 to 24 inches. The furnace is open at the top for the escape of the flame and gases, and for the admission of the charge, consisting of pig-iron, waste or old metal, coke, and lime in due proportion. The lime acts as a flux, and much assists the fusion; chalk or oyster-shells are used where conveniently accessible.

Fig. 1550



Cupola-Furnace.

At the back of the furnace are several tuyere-holes, one above another, through which the air is urged by a blower. As the fluid metal collects below, the air is admitted at a higher aperture, and the lower blast-hole is stopped.

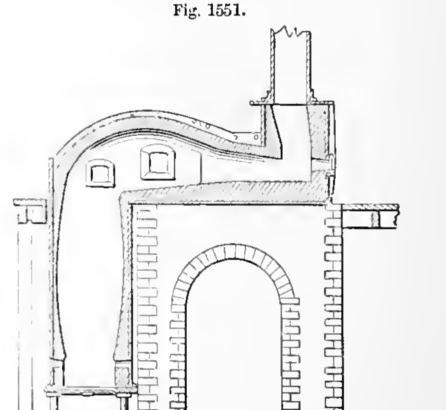
The front of the furnace has a large opening at which clinkers, slag, and unconsumed fuel are removed when cleaning the furnace. This aperture is closed by a *guard-plate*, fixed on by staples attached to the iron case of the furnace. In the center of the *guard-plate* is the *tapping-hole*, which is closed during the melting by a ramming of sand.

Some furnaces are made rectangular or cylindrical, with separate plates like staves, bound by hoops, so that the furnace may be taken down if the charge should accidentally become solidified therein.

Cupolas are built on a scale much exceeding the one just described; the capacity of such may be gathered from the articles CANNON, ANVIL, STATUARY, BELL, etc. A large cupola for anvil-casting is 74 inches in diameter, lined with fire-brick, and having a melting capacity of twelve tons. It has three tuyeres, 9 inches area at the mouth, and situate on three sides of the circle. The holes are in four series. The blast, for this and three other furnaces, is from two revolving fans, 5 feet diameter, and making 1,000 revolutions per minute.

In Fig. 1551 is shown a combination of the reverberatory and smelting-furnace, in which the

Fig. 1551.



Reverberatory and Cupola.

charge is first heated on the hearth of the former, and from thence runs or is poled into the cupola. The heat passing from the latter is utilized in the preliminary heating of the charge.

Cupped. (*Machinery.*) Depressed at the center. Dished. The depression around the eye of a millstone is called the *bosom*.

Cup'ping In'stru-ment. The most ancient form of cupping was a sucking action by means of the mouth. Job refers to sucking the poison of asps; from a wound, doubtless. Machaon "sucked forth the blood" from the wounds of Menelaus. Eleanor, the queen, drew the poison from the wounds of her husband, the English king. Tubes were early substituted for the lips, to avoid contact of the purulent matter with the mouth. Blood-letting is still performed by the Hindoos, Chinese, and Malays, by means of a copper cup and tube, the mouth being applied to the latter.

In the late Dr. Abbott's museum of Egyptian Antiquities, New York City, are three of the ancient cupping-horns, similar to those used through the East at the present time. The operator exhausts the air through a small hole at the point of the horn, to which he applies his mouth, and then covers it with a piece of leather, which is attached to it for that purpose. They were found in tombs at Sakkarah.

Cupping-instruments are described by Hippocrates 413 B. C., and by Celsus 20 B. C.

Hero of Alexandria states that the instrument is intended to be used *without fire*, referring to the practice then in vogue of rarefying the air within the tube as a means of obtaining a partial vacuum. The cupping-glass (*A*, Fig. 1552) described by Hero, has an outer chamber with an open mouth *a*, and an inner chamber *b*, divided from the former by a diaphragm *f*; *m* is a valve which governs the opening *e* in the diaphragm; the valve *d* governs the opening *c* by which the chamber *b* is connected with the external air. The valve *d* being opened and the valve *m* closed, the mouth is applied to the opening *c*, and a powerful inspiration is taken, rarefying the air in chamber *b*. This is repeated until the vacuum in *b* is as perfect as can be obtained by means of human inspiration and the muscles of the mouth. The opening of *a* is then applied to the skin of the patient, and the valve *m* being turned "into the void thus created [in *a*] both the flesh and the matter about it will be drawn up through the interstices of the flesh, which we call invisible spaces or pores."

Contrary to common opinion, glass was well known in Egypt 1500 years before Hero.

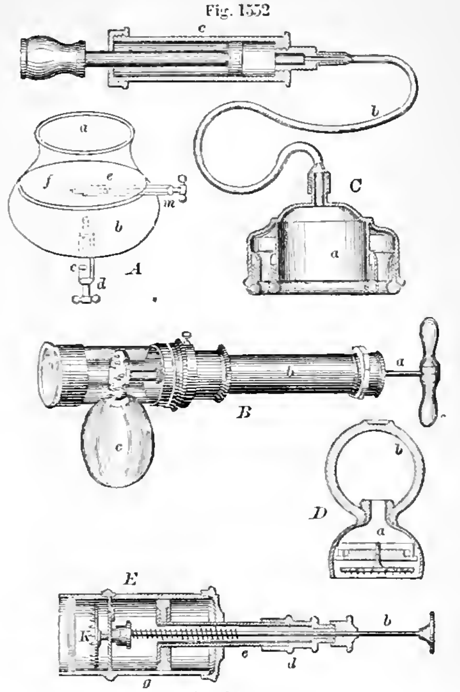
In the cupping-apparatus *B* (Fig. 1552), the glass cylinder has a lip attached suitable for application to the skin, or to the nipple when used as a breast-pump. A central rod *a* has a disk with lancets which act as scarifiers, and the air is exhausted from the cylinder by means of a piston in the tube *b* attached. Detached from the blood-receiver *c*, the air-pump may be used as a syringe.

In the cupping-instrument *C* the receiver *a* is connected by a flexible pipe *b* with the nozzle of an ordinary syringe *c*. The sides of the concentric chamber afford an extended bearing for the cup, and prevent its being driven into the body by the pressure of the atmosphere.

In the instrument *D* the glass has an elastic bulb *b*, by which the partial exhaustion is effected, and has also an adjustable disk provided with puncturing points to lance or irritate the skin.

E (Fig. 1552) is a puncturing and cupping apparatus, in which the scarifier is placed axially within the hollow piston-rod *c*, which works in a stuffing-box on the cylinder *g*. In using, the air is exhausted from *g* by the motion of the piston *e*, operated by the handle *d*. To puncture, the needle-

Fig. 1552



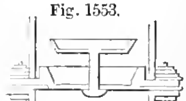
Cupping-Instruments

bar *b* receives a quick downward thrust, forcing the needles on *K* into the protuberant flesh within the cup. The spring returns the needle-bar and disk to position.

Dry cupping is the application of air-exhausted cups to an unscarified place to excite the part, and on an extended scale is known as a DEPURATOR (which see). This was patented in England by N. Smith, 1802. The cup is applied to the patient topically, or an arm or leg may be placed within a suitably shaped chamber, a flexible india-rubber lip adhering to the person and excluding outer air when the air-pump is worked. In the larger form the patient is inclosed in the chamber all but the head, or entirely, as in the AIR-BATH (which see). The action of the skin in each case is excited by the partial removal of external atmospheric pressure.

Cup-valve. (*Steam-engine.*) *a.* A cup-shaped or conical valve, which is guided by a stem to and from its flaring seat.

Fig. 1553.



Cup-Valve.

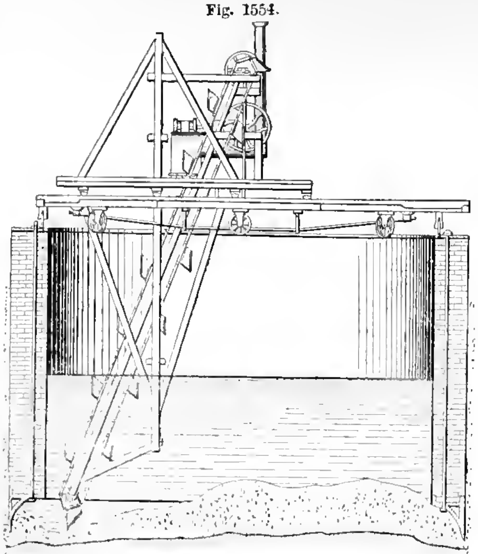
b. A form of balance-valve which opens simultaneously on top and sides.

c. A valve formed by an inverted cup over the end of a pipe or opening.

Curb. A fortified edge or marginal structure, to confine or protect an object, or maintain its shape against external or internal pressure.

1. (*Hydraulic Engineering.*) *a.* A stoned or boarded structure around a well, to keep back the surrounding earth. In Fig. 1554 is shown the curb of the pumping-well of the Chicago Water-Works, which was sunk 29 feet, mostly through quicksand.

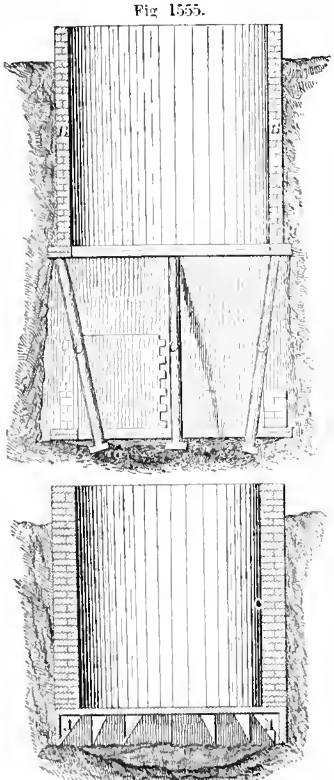
Fig. 1554.



Cylindrical Well-Curb of Chicago Water-Works.

It was $31\frac{1}{2}$ feet internal, 37 feet external, diameter, built of hard brick laid in hydraulic mortar, and plastered inside and out. It was banded every three feet with band-iron, and weighed 440 tons. It was constructed upon a shoe of 32 tons weight, made in eight segments bolted together, and the interior was dredged out without removing the water, to avoid the unsettling of the engine-foundations in the vicinity.

Fig 1555.



Well-Curbs.

In sinking the curb through dry strata or those in which the water may be removed by pumping, the earth is excavated by digging as the work proceeds, and building up as the structure descends. In sinking wells by sections which are curbed before another section is excavated, the earth is removed from the central part and struts inserted, to hold the upper section while the other is built beneath.

Iron curbs are of boiler-iron or of cast-iron segments bolted together, rings being added at the top as the structure descends. The well at Southampton, England, was some hundreds of feet in depth, and curbed in this way. It was intended to be artesian, but the water did not thus respond.

b. A boarded structure to contain concrete, which hardens and acts as a pier or foundation.

c. The outer casing-wheel of a turbine. It is a cylinder inserted into the floor of the forebay, inclosing the wheel which rotates within.

d. A curved shrouding which confines the water against the floats or buckets of a SCOOP-WHEEL or BREAST-WHEEL (which see).

e. The inclosure which leads water from a forebay to a water-wheel. Also called a *mantle*.

2. A breast-wall or retaining wall to hold up a bank of earth.

3. The edge-stone of a sidewalk, pavement, or trottoir.

4. (*Carpentry.*) *a.* The wall-plate at the springing of a dome.

b. The circular plate at the top of a dome into which the ribs are framed.

c. The wall-plate on the top of the permanent portion of a windmill, on which the cap rotates as the wind veers.

5. An inclined circular plate around the margin of a soap or salt kettle, to return what boils over.

6. (*Harness.*) A chain or strap behind the jaw of a horse, connected at its ends to the rings on the upper ends of the branches of a stiff-bit, and forming a fulcrum for the branches, which act as a lever. See BIT.

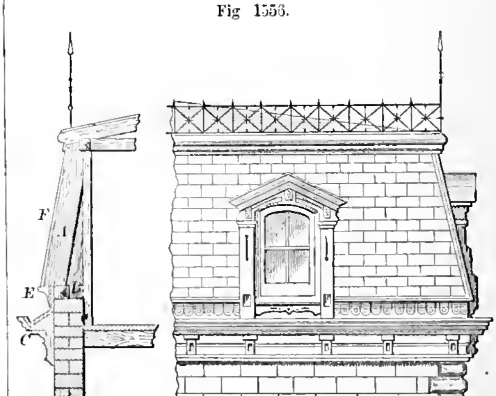
Curb-beam. A beam of a wooden bridge to confine the road material.

Curb-bit. A stiff-bit having *branches* by which a leverage is obtained upon the jaws of a horse. The lower end has rings or loops for the reins, and the upper end has loops for the *curb-chain* and the *cheek-straps* of the head-stall. The curb-chain has usually twisted links, and is fast by one end to the loop of the *off* branch, and is hooked to the loop of the *near* branch. It forms the fulcrum for the leverage of the branches. See BIT.

Curb-pins. (*Horology.*) The pins on the lever of a watch-regulator which embrace the hair-spring of the balance and regulate its vibrations.

Curb-plate. The wall-plate of a circular or elliptical dome or roof.

Fig 1556.



Curb-Roof

Curb-roof. (*Building.*) A roof with canted slopes; having two sets of rafters with different inclinations. Otherwise called a *Mansard-roof*, after the French architect who frequently adopted it; or a *gambrel-roof*, from its crooked shape, like the hind leg of a horse.

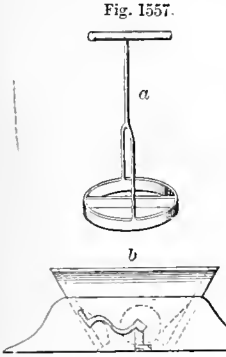
The view on the left represents a section of roof. *A* is the rafter, the foot of which projects over the plate *B*. *C* is the cornice, in which is built the gutter, the metallic lining of which extends nearly to the top of the plate *B*. *E* is a bed-mold covering the ends of the rafters. *F*, slates or shingles running over the edge of the bed-mold *E*. The view on the right shows an elevation of one of these roofs with dormer-window.

Cur-cu'lio Trap. A tray, or a cincture of fiber, attached to the trunk of a plum, apricot, or other curculio-ravaged tree, to intercept the insects which climb up the bark.

Curd-break'er. A frame of wires or slats which is worked to and fro in a vat of cheese-curds, to break the latter into small pieces and enable the whey to drain off. A *curd-cutter*.

Curd-cut'ter. A spindle with revolving knives on an axle, for cutting the curd to expedite the separation of the whey. (*b*, Fig. 1557.)

Fig. 1557.



Curd-Cutters.

Another form of curd-cutter (*a*) is a hoop with a diametric knife having an arched stem and wooden handle. It is used by an up-and-down motion, the curd being in a tub.

Curl'ing-i'ron. A heated rod, or a tube with an internal heater, around which hair is bent and pressed to curl it.

The curling-iron of the Romans was hollow, and named *calamustrum*, from its resemblance to a reed (*calamus*). The use was common among both sexes in the imperial city. It was the duty of the slaves. The same practice, there is no doubt, obtained in Egypt. The ladies of the latter land prided themselves in magnificent coiffures, as we see in the works of Lepsius, Rossellini, Champollion, etc.

The beards of the kings of Nineveh and other kingdoms of the basin of the Euphrates and Tigris were no doubt indebted to the curling iron or tongs; their beards fell in splendid ringlets over the throat and chest.

Curl'ing-tongs. A tongs having one round member and one semi-tubular, between and around which hair is wound to curl it.

Cur'rent. The *fall* or *slope* of a platform or sheet-metal roof, to carry off the water. Gutters usually have a *current* of $\frac{1}{4}$ inch to the foot.

A flow of water. The direction is the *set* of the current; the rate is the *drift* of the current.

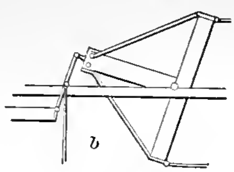
Cur'rent-fend'er. A structure to ward off the current from a bank which it may otherwise undermine.

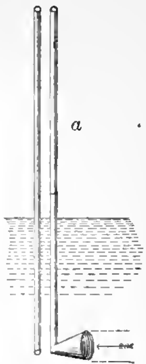
Cur'rent-gage. See CURRENT-METER.

Cur'rent-me'ter. An instrument for measuring the velocity of currents.

1. The *Pitot tube* (*a*, Fig. 1558), which acts by the ascension of water in a bent pipe whose lower orifice is presented squarely to the current, the indication being read by a float or graduation in or upon the vertical part of the tube.

Fig. 1558.





Current-Meters.

2. One (*b*) which acts as a dynamometer, by opposing a resisting body to the action of the current, and indicating the force of the action by a dial or graduated bar. This is Boileau's.

3. The dynamometer current-gage of Woltmann, 1790, is a light water-wheel operated by the current, and having on its axis an endless screw, which operates toothed wheels and a register, the rate or force being deduced from the rotations in a given time.

The *velocimeter* is a similarly constructed instrument with a converse application, being a spiral wheel attached to a ship and showing by its revolutions the rate of progression of the vessel through the water.

The technical language in which the flow of water and its channels are known and described is as follows: —

Bed; the water-course, having a *bottom* and two *sides* or *shores*. When the latter are described as *right* or *left* hand, going down stream is assumed.

The *transverse section* is a vertical plane at right angles to the course of the current. The *perimeter* is the length of this section in the bed.

The *longitudinal section* or *profile* is a vertical plane in the course of the flowing water.

The *slope* or *declivity* is the mean angle of inclination of the surface of the water to the horizon.

The *fall* is the difference in the hight at any two points of determinate distance apart; as, for instance, 8 inches to the mile.

The *line of current* is the point of maximum velocity.

The *mid-channel* is the deepest part of the bed. The velocity is greater at the surface than the bed. The surface is higher in the current than at the shore when the river is rising, lower than at the shore when the river is falling.

Herodotus (II. 4, 5) reports the Egyptian priests as saying, that in the time of Men [Menes] "all Egypt, except the Thebaic canton, was a marsh, none of the land below Lake Mœris then showing itself above the surface of the water. This is [now] a distance of seven days sail from the sea up the river. What they said of their country seemed to me very reasonable; for any one who sees Egypt, without having heard a word of it before, must perceive, if he have only common powers of observation, that the Egypt to which the Greeks go in their ships is an acquired country, the gift of the river." Wilkinson contradicts the statement, very unreasonably.

In this connection it may be remarked that the alluvial plain at the mouth of the Meander, in Asia Minor, has been advanced toward the sea, in the historic times, a distance of twelve or thirteen miles.

At Ephesus there is now a plain, of three miles width, between the temple and the sea, which has been entirely created since the days of Herodotus.

Ostia, the former port of Rome, is now many miles inland.

Herodotus referred (450 B. C.) to the action of the river Meander, and also stated that "the river Achelous, which, after passing through Acarnania, empties itself into the sea opposite to the islands Echinades, has already joined one half of them to the continent." — Book II. ch. 10.

The volume of water poured during twenty-four hours into the Mediterranean by the Nile is, —

When low	150,566,392,368	cubic meters.
When high	705,514,667,440	" "

The Nile at the first cataract, at Assouan, is 300 feet above its level at Cairo (578 miles), and 365 feet above the Mediterranean (578 + 154 to the Rosetta mouth = 732 miles). The fall from Assouan to Cairo is therefore about 0.54 feet per mile; from Cairo to the Damietta mouth, about .31 feet per mile. From Assouan to Damietta mouth, an average of 0.524 feet per mile.

The Nile deposit is estimated by Wilkinson, at Elephantine, as equal to nine feet in 1700 years; at Thebes, seven feet in an equal period.

According to Herodotus, a rise of the Nile equal to 8 cubits overflowed all Egypt below Memphis, in the time of Mœris: "Now Mœris had not been dead 900 years when I heard this of the priests, yet at the present day, unless the river rise 15 or 16 cubits, it does not overflow the land." — HERODOTUS, II. 13. See NILOMETER.

The mean annual discharge of the Mississippi is calculated at 19,500,000,000,000 cubic feet, carrying down 812,500,000,000 pounds of sedimentary matter, equal to one square mile of deposit 241 feet in depth.

The river advances into the Gulf 262 feet per annum.

The fall of the

Lower Mississippi per mile is	.32 of a foot.
Ohio per mile is	.43 " "
Missouri below Fort Union per mile is	.95 " "
Upper Mississippi below St. Paul per mile is	.42 " "

Cur'rent-mill. A mill driven by a current-wheel, and usually on board a moored vessel with stream-driven paddles.

The first notice of current-mills is the account of the recourse had to them by Belisarius, A. D. 536, when the Romans were besieged by Vitiges the Ostragoth, who had cut the fourteen aqueducts which brought water to the imperial city. The surplus water of the aqueducts drove the grain-mills of the city, and the recourse had by Belisarius to moored twin-vessels provided with paddles, and the mills, enabled the people to eat bread instead of parched wheat and frumenty.

The German crusaders in the eleventh century burnt seven floating mills on a stream in Bulgaria, — a pretty fair specimen of the crusading rabble.

The current-wheel of Belisarius was patented by Hawkins in England in 1802, and by several other parties before and since, both there and here. See CURRENT-WHEEL.

Cur'rent-reg'u-la'tor. (*Telegraphy.*) A device for determining the intensity of the current allowed to pass a given point. It usually consists of interposed coils of greater or less resistance.

Cur'rent-wheel. The *current-wheel* is perhaps the first application of the force of water in motion to driving machinery. The *noria* has been in use for thousands of years in Egypt, Persia, Arabia, and Syria, and was introduced by the Romans or Saracens (probably the latter) into Spain.

The *noria*, as a water-wheel, has radial floats, which are sufficiently submerged in the current of the river to be acted upon by the water and give rotation to the wheel on its horizontal axis. On the side of the wheel near its periphery are pivoted buckets, which fill as they dip beneath the water, and are tipped, on reaching their highest elevation, by contact with a fixed obstacle, thus discharging their contents consecutively into a chute which conveys it to a reservoir. Hundreds of these wheels are working day and night the year round in the rivers and streams of Syria and Palestine. The *noria* has many modifications which do not come within the denomination of *current-wheel.* The term *Na'Ura* is applied in Syria and Palestine to any device which has pots or buckets attached to a wheel or to a rope passing over a wheel, filled with water at the lowest portion of their revolution, and discharging into a chute at their highest elevation, whether worked by the current or otherwise. See NORIA.

The *tympanum* is another form of *current-wheel*, and like the *noria* has an Eastern origin. It is frequently called the Persian. Unlike the *noria*, it is only capable of lifting water to a height about equal to its radius, while the *noria* lifts water to a height nearly equal to its diameter. See TYMPANUM.

In the first century B. C. water-wheels for driving mills were used in Asia Minor and on the Tiber. In the former case we suppose, and in the latter case we know, that these were *current-wheels.*

Strabo, Vitruvius, Pliny, and Procopius have described them at various times from 70 B. C. to A. D. 555. They were used on the Tiber on a large scale by Belisarius, during the siege of Rome, when the supply by the aqueducts was cut off by the Goth Vitiges, in the reign of Justinian, A. D. 536. See CURRENT-MILL.

The tide and current wheel, erected first in the vicinity of the north end of London Bridge, and subsequently under its northern arch, was erected by Peter Morice, a Dutchman, in 1582, and operated force-pumps which supplied a part of London with water. The stand-pipe from the pump was 120 feet high, and conducted the water to a cistern at that height, where it was distributed to the dwelling-houses in the vicinity, and by four lead-pipes to cisterns at Bishopsgate, Aldgate, the Bridge, and Wall-brook. The amount raised was about 216 gallons per minute. The wheel worked sixteen pumps, each 7 inches in diameter, and having a stroke of 30 inches. Several other similar machines were erected at other points, and were similarly driven.

The axle of the trundle was prolonged at each end, and had quadruple cranks which connected by rods to the ends of four walking-beams 24 feet long, whose other ends worked the piston-rods of the pumps. The axis of oscillation of the lever supporting the wheel, and by which it was adjusted to the state of the tide, was coincident with the axle of the trundle, so that the latter engaged with the 8-feet cog-wheel in any condition of vertical adjustment. Each end of the walking-beam was made effective.

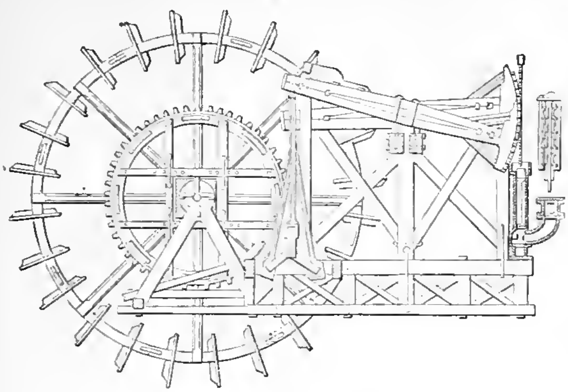
During the seventeenth and eighteenth centuries the works were extended from time to time, and occupied one after another of the arches.

In the first arch of the bridge was one wheel working sixteen force-pumps. In the third arch were three wheels, working fifty-two pumps. The united effect was 2,052 gallons per minute, raised 120 feet high.

In 1767 Smeaton added wheels in the fifth arch. Steam-engines were added about this time to assist at low water and at neap-tides. Thus the matter remained till 1821. The present daily supply of water to London is equal to a lake of 50 acres, 3 feet deep.

Stow, the antiquarian and historian, describes the works in 1600; and Beighton in 1731 gives an account of them at that date. The water-wheels at that time were placed under several of the arches. The axle of a wheel was 19 feet long, 3 feet diameter. The radial arms supported the rings and twenty-six floats, 14 feet long and 18 inches wide. The axles turned on brass gudgeons supported in counterpoised levers, which permitted the vertical adjustment of the wheel as the tide rose and fell. On the axis of the wheel was a cog-wheel 8 feet in diameter and having forty-four cogs; this meshed into a trundle-wheel 4½ feet in diameter and having 20 rounds, and whose iron axle revolved in brasses.

Fig. 1559.

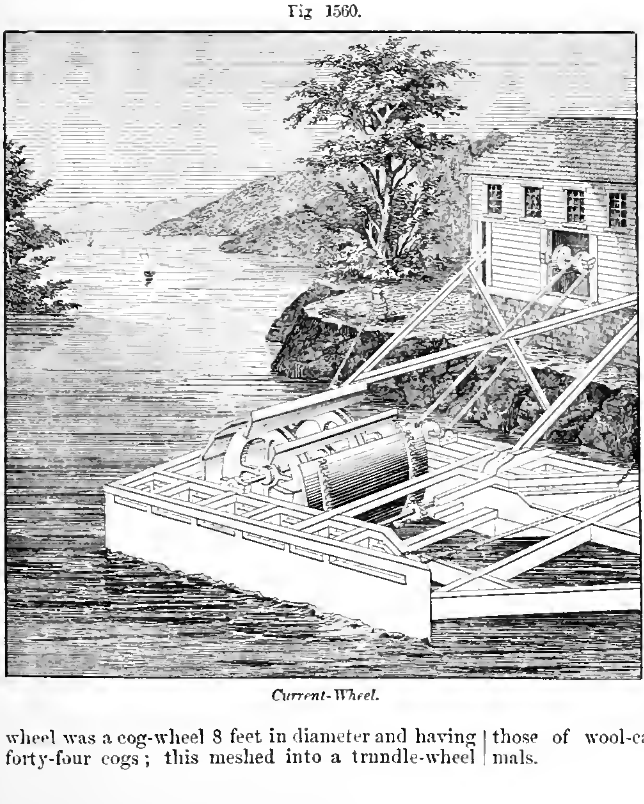


Current-Wheel, London, 1731.

Fig. 1560 is an illustration of a floating frame in which an *undershot* wheel is journaled; the frame as represented consists of two scows connected by beams and having a skeleton prow to ward off driftwood. The prows of the barges are wedge-shaped, to direct the stream into the space between them occupied by the water-wheel.

A curved gate conforming to the circumference of the wheel regulates the amount of water impinging on the buckets and consequently the speed of the wheel, and also stops the wheel by cutting off the stream from the buckets. The main or wheel-shaft carries on the shore end a bevel-gear that drives a similar gear, from the shaft of which power is carried, by means of pulleys and belts or shafting, to the mill standing upon the bank. The receiving pulley and shaft are hung in a frame, one end of which is hinged or pivoted to the shore-side float or scow, and the other to the mill-building. Thus, whether the water be high or low, the belt is always kept "taut." Chains or ropes moor the floating scows to the shore, and the pivoted frame holds them in position.

Fig 1560.



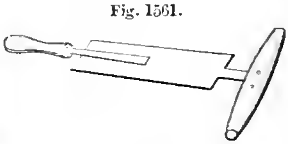
Current-Wheel.

Cur'ri-cle. A two-wheel chaise with a pole for a pair of horses.

Cur'rier's Knife. A large, two-handled knife, with a recurved edge, employed by curriers to shave or pare the flesh side of hides.

The knife is about 12 inches long and 5 wide; one end has a plain handle and the other a cross-handle, in the direction of the plane of the blade. The edge of the knife is brought up by means of a whetstone, and a wire edge is constantly preserved by a steel wire which acts as a burnisher.

Fig. 1561.



Currier's Knife.

Cur'ri-er's Tools. See: —

Beam.
Beam-knife.
Cleaner.
Clearing-stone.
Crippler.
Currier's knife.
Horse.
Mace.
Pommel.
Raising-board.
Round knife.
Rub-stone.
Slicker.
Steel.
Striking-knife.
Unhairing-knife.

Cur'ry-card. A leather or wooden slip with inserted teeth like those of wool-cards, and used for currying animals.

Cur'ry-comb. An implement with projecting serrated ribs, used for grooming horses.

In the sculptures of Nimroud is represented a tent within which a groom is currying a horse.

Cur'ry-ing. The process of shearing the green, tanned skins, to bring them to a thickness, and afterwards dressing them by *daubing*, *graining*, and surface-finishing; transmuting the tanned skins into merchantable leather.

The mechanical part of the process is performed by a peculiar knife (see CURRIER'S KNIFE) upon a nearly vertical *beam* over which the hide is placed.

The mode of currying skins upon a slanting beam or board is shown in the ancient paintings of Kourna, Thebes. *Slicking* with a sharp edge is also shown.

Cur'ry-ing-glove. A heavy glove having a pile of coir woven into a hempen fabric, and shaped to the hand. Back and palm are alike, and either may be used for currying.

Cur'sor. A part of a mathematical instrument which slides on the main portion; as, —

The movable leg of a beam-compass.
The joint of the proportional compasses.
The hand of a barometer.
The beam of the trammel.
The slide of a Gunter rule.
The adjustable plate of a vernier.
The moving wire in a reading microscope.

Cur'tail-step. (*Joinery.*) The bottom step of a stairs, when finished with a scroll and similar to the handrail.

Cur'tain. 1. (*Fortification.*) That portion of a *rampart* which extends between and joins the *flanks* of two *bastions*. See BASTION.

2. (*Locksmithing.*) A shifting plate, which, when the key is withdrawn, interposes so as to screen the inner works from being seen or reached by tools.

3. A strip of leather which overlaps the parting of a trunk.

4. A dependent cloth serving as a screen.

Cur'tain-pa'per. A heavy paper, printed and otherwise ornamented, for window-shades.

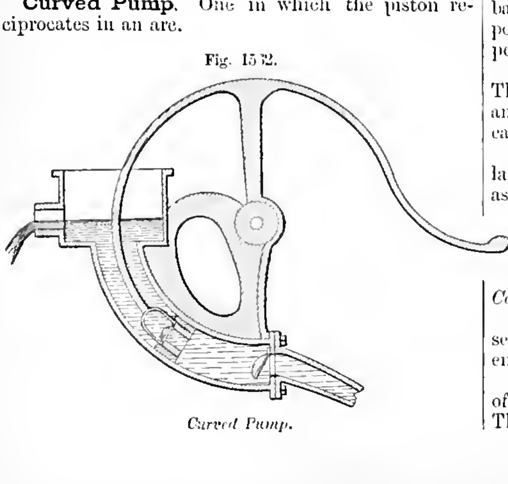
Cur'tal-axe. A short sword with a curved blade. The name has been modified from time to time: *Coutel-hache; cortel-axe; curtle-axe; curtal-axe; coute-lace; curte-lasse; cutlass.*

Curve. 1. A draftsman's instrument having one or a variety of curves of various characters other than arcs, which may be struck by a compass. Some are constructed for specific purposes, such as *shipwright's curves, radii-curves*, etc.

2. A bend in road, canal, or railway; especially in the track of the latter.

Curved Pump. One in which the piston reciprocates in an arc.

Fig. 1562.

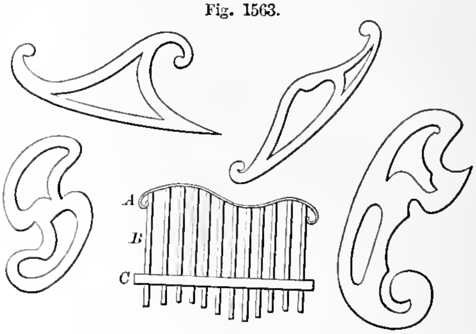


Curved Pump.

Cur'vi-lin'e-ar. A drafting-instrument used in describing irregular curves. The various shapes of its marginal outline enable it to be fitted into position so as to project or transcribe the curve required. M. Desalier, of Paris, invented a machine for generating the curves and marking out the patterns. It is capable of making 1,200 varieties of curves.

The illustration shows one adjustable instrument. The flexible bar *A* is set to any given curve by the adjustment of the ordinal rods *B* in the bar *C*. It

Fig. 1563.



Curvilinear.

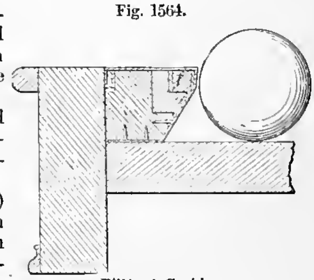
has a greater range of capacity than the *arcograph*, being adapted for double, irregular, and mixed curves.

Curv'o-graph. An instrument for drawing a curve without reference to the center. It is usually an elastic strip, which is adjustable to a given curve, and serves to transfer the latter to another plat or another place on the plat.

Cush'ion. 1. A padded seat, back, or arm of a sofa, lounge, or chair.

An ancient Egyptian cushion, made of linen and stuffed with the feathers of water-fowl, is preserved in the British Museum. See CHAIR.

Fig. 1564.



Billiard-Cushion.

2. The padded edge of a billiard-table, which rebounds the balls.

3. (*Engraving.*) A flat leathern bag filled with pounce and supporting the plate.

4. (*Gilding.*) The pad on which the gilder spreads his gold-leaf, and from which he takes it by a camel's-hair tool called a *tip*.

5. The pillow of the bone-lace maker. Pillow-lace is made by hand, and is of several kinds, known as Valenciennes, Mechlin, Honiton, etc. See LACE.

6. (*Electricity.*) The rubber smeared with amalgam, and whose friction against the glass cylinder or disk causes the electrical excitation.

7. (*Architecture.*) *a.* The impost-stone on a pier. *Coussinet.*

b. A capital of a column so sculptured as to resemble a cushion pressed down by the weight of its entablature.

8. (*Steam-engine.*) A body of steam at the end of a cylinder to receive the impact of the piston. This is accomplished by closing the eduction-port a

little before the end of the stroke, or by opening the induction-port on the same side of the piston, a little before the end of the stroke.

Cush'ion-raft'er. (*Carpentry.*) An auxiliary rafter beneath a principal one, to sustain a great strain.

Cusp. (*Architecture.*) An ornament in stonework of the Gothic order. It consists of projecting points, formed by the meeting of curves, and is the foundation of the peculiar foliation, feathering, tracery, archery, and panels of the order.

Cut. 1. A term for a certain quantity of yarn.

2. The style of the notches of a file ; as, —

Rough cut.	Smooth cut.
Bastard cut.	Dead-smooth cut.
Second cut.	

3. Cut of a letter ; its size and shape.

4. Cut of a ponton-bridge ; the water-way between the pontons.

Cut-glass. Flint-glass ornamented by cutting away portions.

The decanter, tumbler, or other object, is held against a revolving wheel, whose surface is provided with a grinding material ; and afterwards to another wheel with a polishing powder.

The first, or *cutting*-wheel, is of iron, furnished with sand and water.

The second, or *smoothing*-wheel, is of stone, with clear water, to work out the scratches of the grinder.

The third, or *polishing*-wheel, is of wood, with rottenstone or putty-powder for polishing.

Cut-in Notes. (*Printing.*) Notes which occupy spaces taken out of the text, whose lines are shortened to give room therefor.

Cu'ti-sec'tor. A knife consisting of a pair of

Fig. 1565.

Tiemann's Cutisector.

parallel blades, adjustable as to relative distance, and used in making thin sections for microscopy.

Cut'lass. Abbreviated from *curtal-axe.* A short, heavy, curving sword ; especially used by seamen in boarding or repelling boarders. Rosalind calls it a *curtle-axe.*

Cut'ler-y. Knives, swords, chisels, and axes were originally made of material found ready to the hand, and this varied with the place. Among the Caribs they were made of shells of the *Strombus gigas*, which is still fished for off the island of Barbadoes. Flint knives and tools were used in almost all parts of Europe and America ; they are found under circumstances which indicate that man was contemporaneous with a number of extinct animals, such as the *Bos longifrons*, the Irish elk, the *Elephas primigenius*, and others. The stone knives and hatchets of this prehistoric period are found in great variety and number, and in some cases a blade or edge of obsidian was secured to a handle, or a row of arrow-heads or blades fastened in the grooved edge of a stock, forming a jagged knife or saw. This has been found among the sepulchral mounds of the Iroquois, and was also among the weapons of the people met by Herrera, who says : "The Indians had swords made of wood, having a gutter in the forepart, in which were sharp-edged flints strongly fixed with a sort of bitumen and thread." Among the Mexicans this toothed blade was armed with obsidian, and the Spaniards found it a very destructive weapon. Stephens found the same weapon represented in sculpture in the ruins of Central America and Yucatan. In process of time copper, then bronze, and then iron and steel, were introduced. For analyses of the ancient bronzes, see ALLOYS.

In the Egyptian mode of embalming dead bodies, and in practicing the rite of circumcision, a knife of flint, obsidian, or other sharp stone, was used. We read of it in Exodus where Zipporah took a sharp stone and used it for the latter purpose. Herodotus and Diodorus Siculus also refer to "sharp Ethiopic stone" as used in disemboweling corpses in the process of embalming, no knife of metal being allowed to be used upon the body. The custom of using a shard of flint has descended to our day among some of the nations who retain the practice of circumcision.

Under the head of cutlery are included knives of all kinds, scissors, shears, razors, and forks. It is only by a stretch of the term that it can be made to include edge-tools, such as axes, adzes, chisels, gouges, plane-bits, etc. These are not cutlery. See KNIFE ; SCISSORS ; SHEARS ; FORK ; RAZOR ; SURGICAL INSTRUMENTS ; DAMASKEENING ; FORGING ; TEMPERING ; SWORD, etc.

Cut-mark. A mark made upon a set of warp-threads before placing on the warp-beam of the loom, to mark off a certain definite length, the mark defining the end of which shall appear in the woven piece and afford a measure to cut by.

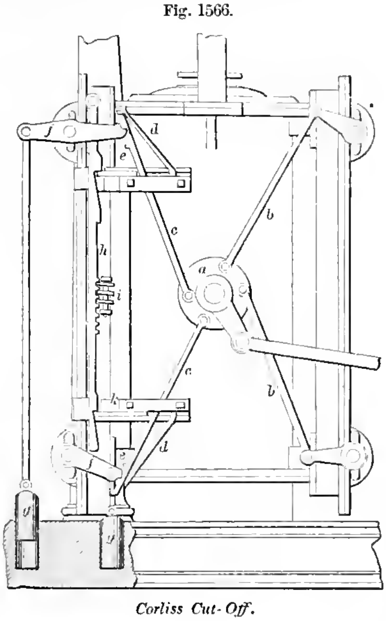
Cut-nail. A nail *cut* from a nail-plate, in contradistinction to one forged from a nail-rod, as a clasp, horse-shoe, or flat-head nail.

Mr. Odion, of Massachusetts, invented a machine for making cut-nails in 1816. Mr. Reed, of the same State, followed with another machine for the same purpose.

Walter Hunt's double-reciprocating nail-machine was introduced in 1841. See NAIL.

Cut-off. The term is applied to that mode of using steam or other elastic fluid in which it is admitted to the cylinder during a portion only of the stroke of the piston ; the steam, after the induction ceases, working expansively in the cylinder during the remainder of the stroke of the piston.

Fig. 1566.



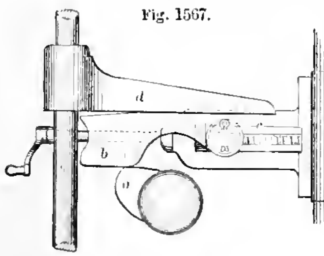
Corliss Cut-Off.

The *cut-off* in locomotive-engines is effected by a certain adjustment of the LINK-MOTION (which see).

The *cut-off*, in many steam-engines, is effected by the governor, which is so connected to the valve-gear as to vary the throw of the valve-rod, modifying it according to the speed of the engine; the effect being that an acceleration of speed works a diminution of steam inducted and conversely, the object being to secure uniformity of speed.

The CORLISS cut-off, 1851 (Fig. 1566), has an oscillating disk *a*, placed centrally on the cylinder with four pins, to which rods are attached, imparting motion to the valves. Two of the rods *b b* connect permanently with the exhaust, and two *c c* detachably by springs *d* and hooks *e* with the inlet-valves. Cranks *f* on the ends of the valve-stems fit into the hooks, and, becoming detached, close the valve by a weight *g*. A lifting-rod *h*, with rack operated by a worm-wheel *i*, and having inclines *k* bearing against stops, makes the valves adjustable.

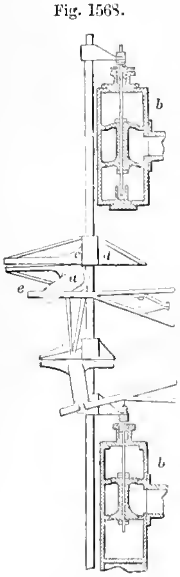
Fig. 1567.



Winter's Cut-Off.

WINTER'S cut-off, 1859 (Fig. 1567), has a crank on the main shaft, which imparts motion to a revolving shaft, arranged between the upper and lower steam-chests; a cam *a* on the shaft operates the swinging toe *b*, which is pivoted in a sliding, adjustable box *c* in a guide. A recess in lower side of said toe allows the cam to clear the toe when working full stroke, and the corner of the recess has a friction-roller which is struck by the cam, causing the lifters *d* to operate the valves. The swinging toes drop when the cam passes them.

Fig. 1568.

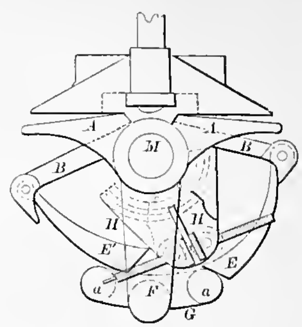


Stevens's Cut-Off.

In STEVENS'S cut-off, 1841 (Fig. 1568), a rotary shaft *a* is placed between the upper and lower steam-chests *b b*, and has two lifters *c d* placed on opposite sides of its center, which alternately raise and depress the valves by the toes *e* on the rock-shaft. To adjust the toes, a slot and pin are provided in the rock-shaft arm. To cut off shorter, the toes must be dropped, the pin raised, and the eccentric set ahead. To cut off longer, reverse the operation.

ALLEN AND WELLS'S cut-off, 1853 (Fig. 1569). Upon the rock-shaft *M* are arranged the loose steam-toes *B B*, with pawls *E E'* pivoted to their outer ends, which are raised by rollers *a a* on a cross-arm *G* of the rock-shaft arm *F*, and when they clear the rollers they drop inward, thus opening and closing the valves. To adjust them, two arms *H H* are provided with a right and left hand screw. The arms, having motion nearly coincident with the piston, start downwards at the same time the rock-shaft rises. The exhaust-toes *A A* are permanently attached.

Fig. 1569.



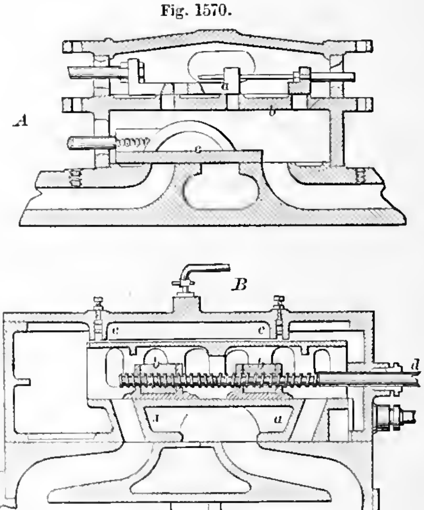
Allen's Cut-Off.

In the gridiron valve (*A*, Fig. 1570) the steam-chest is divided by a longitudinal partition *b* provided with suitable ports, over which is arranged the cut-off valve *a*, and in the lower part of the chest is the usual slide-valve *c*.

In the MERRICK cut-off (*B*, Fig. 1570) the steam-valve *a* is provided with ports through its lower part, over which the cut-off valves *b b* slide. They are made adjustable by a right and left hand screw on the valve-stem *d*, by which they may be drawn together or forced apart. In the steam-chest cover are arranged adjustable rings *c c*, that bear on the back of the valve *a* to make it a balanced valve. The space inclosed in the rings connects with the condenser.

SICKEL'S cut-off (Fig. 1571). A rock-shaft *a* operated by the rod *b* from the eccentric is placed midway of the steam-chests, and provided with the usual toes, by which the lifters *e* and rods *d d* of the valves are operated. To seat them without slamming, the valve-stems are provided with dash-pots *c c*; and to seat them suddenly, a spring-catch is secured on the stems, against which a vibratory wiper *g* passes, and, when released, the valves are seated instantaneously.

Fig. 1570.

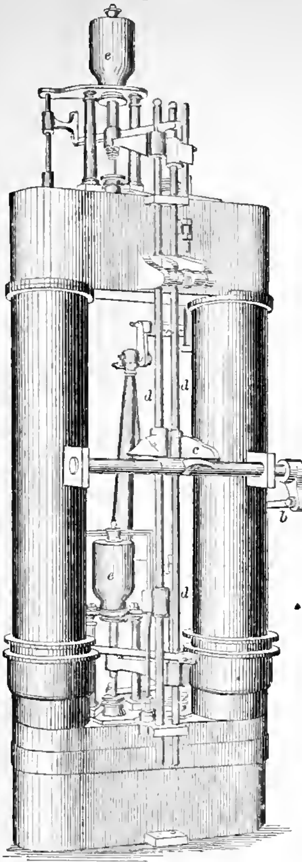


Cut-Off Slide-Valve.

A *drag cut-off* is one actuated directly by the main valve.

2. A valve or gate in a spout, to stop discharge; as in grain-spout when the required weight or quantity has been discharged or the receiving vessel is full.

Fig. 1571.

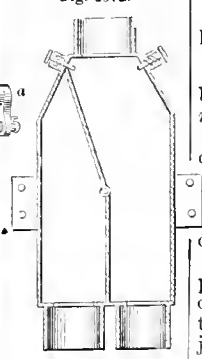


Sickel's Cut-Off.

3. A device in a rain-water spout to send the falling water in either of two directions, as, for instance, to the gutter until the roof is clean, and then to the cistern.

4. A rod on a reaper, to hold up the falling grain during the clearing of the fallen grain from the platform.

Fig. 1572.



Rain-Water Cut-Off.

Cut-off Valve. A valve arranged to close the induction-ports of a steam-cylinder at any given period before the close of the stroke of the piston, in order that the steam may be used expansively in the interval. See CUT-OFF.

Cut-out. (*Telegraphy.*) A species of switch used in telegraph-offices to connect the wires passing through the office, and "cut out" the instrument from the circuit. Usually a mere lever, pivoted between the wires leading to and from the instrument, so that, on being turned in the proper direction, it will connect the wires.

Cut-pile. (*Fabric.*) A fabric woven in loops, which are subsequently cut so as to give a pile (hairy) surface, such as velvet, plush, Wilton carpet, etc.

Cut-splay. The oblique cutting of the edges of bricks in certain kinds of fancy brick-work.

Cut-stone. A *hewn* stone. Ashlars reduced to form by chisel and mallet.

Cut'tee. The box to hold the quills in a weaver's loom.

Cut'ter. 1. (*Husbandry.*) That portion of a mower or reaper which actually severs the stalk. The varieties are numerous, but the general verdict of approval has been given to what may be called the *saw*,— a term which describes generally a device consisting of projecting teeth or *sections* affixed to a *bar* and reciprocated longitudinally of the latter. See HARVESTER-CUTTER.

2. (*Nautical.*) *a.* A vessel with one mast, having fore and aft sails. The spars are a *mast, boom, gaff*, and *bowsprit.*

Cutters are usually small, but the fancy has sometimes been to make them as large as 460 tons and 28 guns (the *Viper*). They are either clincher or carvel build; have no jib-stay, the jib hoisting and hanging by the halliards alone.

A cutter carries a fore and aft main-sail, gaff-topsail, stay, foresail, and jib.

b. A boat smaller than a barge, and pulling from four to eight oars. It is from 22 to 30 feet long, and has a beam equal to .29 to .25 of its length. A number are required for the miscellaneous purposes of a large ship, and are known as the first, second, etc., cutters.

3. A one-horse sleigh.

4. A soft brick adapted to be rubbed down to the required shape for ornamental brick-work or arches.

5. A wad-punch.

6. A revolving cutting-tool of a gear-cutter, a planing-machine, etc. See CUTTER-HEAD.

7. An upright chisel on an anvil. A *hack-iron.*

8. The *router* or scorper portion of the center-bit, which removes the portion circumscribed by the *nicker.*

9. A burin, an engraver's tool; as a *tint*-cutter or *tint-tool.*

10. A file-chisel.

11. A *peg-cutter*, or *float.*

12. (*Agriculture.*) An implement or machine for cutting feed. See STRAW-CUTTER; ROOT-CUTTER, etc.

Cutter-bar. 1. (*Boring-machinery.*) A bar supported between lathe-centers or otherwise in the axis of the cylinder to be bored, and carrying the cutting-tool. By various modifications having the same object in view, the tool-stock, cutter-bar, or cylinder may be moved, so as to cause the tool to pass around inside the cylinder or conversely, and also cause it to traverse from end to end. See BORING-MACHINE.

2. (*Harvester.*) A bar, usually reciprocating longitudinally, and having attached to it the triangular knives or sickles, which slip to and fro in the slots of the fingers, and cut the grain or grass as the machine progresses.

The bar carrying the fingers is the *finger-bar.*

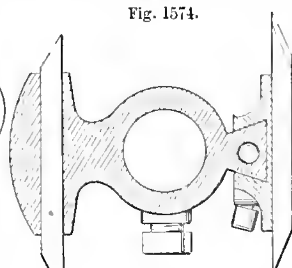
Cut'ter-grind'er. A grindstone or emery-wheel specially constructed for grinding the sections of the cutter-bars of reaping and mowing machines.

Cut'ter-head. A rotating head, either dressed

Fig. 1573.

Rotary Cutter.

Fig. 1574.



Cutter-Head.

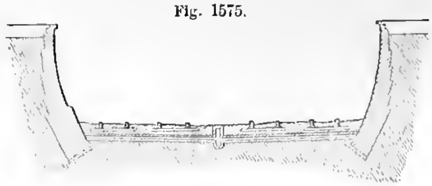
and ground to form a cutter, or having means for the attaching of bits or blades thereto, as in the illustrations.

Cut'ter-stock. A head or holder in which a cutting blade or tool is fastened for use.

Cut'ting. 1. (*Railroading.*) An excavation for the purpose of a road, railroad, or canal. When the earth is not required for a *fill* or embankment, it is called *waste.*

When the sides are not secure, sufficient slope must be allowed or retaining-walls constructed.

Fig. 1575.



Cutting.

These walls *batter* towards the bank in order to withstand the thrust. See BATTER; BREAST-WALL; RETAINING-WALL.

2. (*Mining.*) A poor quality of ore mixed with that which is better.

Cut′ting-board. A board for the bench or lap, in cutting out leather or cloth for clothing.

Cut′ting-box. A machine for cutting hay, straw, or corn-stalk into short feed. See STRAW-CUTTER.

Cut′ting-com′pass. A compass, one of whose legs is a cutter, to make washers, wads, and circular disks of paper for other uses.

Cut′ting-down Line. (*Shipbuilding.*) A curved line on the sheer-plan, which touches the lowest part of the inner surface of each of the frames. It determines the depth of the floor-timbers and the hight of the dead-wood fore and aft.

Cut′ting-down Staff. (*Shipbuilding.*) A rod having marked upon it the hight of the *cutting-down line* above the keel at the several frames.

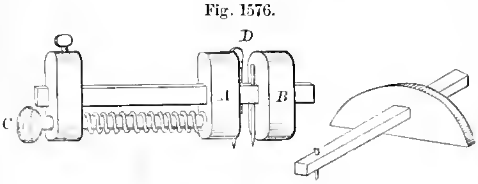
Cut′ting-en′gine. (*Silk-machinery.*) A machine in which refuse or floss silk — the fibers having been previously disentangled, straightened, and laid parallel by the HACKLE, FILLING-ENGINE, and DRAWING-FRAME (which see) — are cut into lengths of about 1¼ inches, so as to enable them to be treated as a staple by the carding-machine and the machines which follow in the cotton process, bringing the fiber to a *sliver*, a *roving*, a *thread*, suitable for weaving.

The cutting-engine has feed-rollers, and an intermittingly acting knife, somewhat similar to a chaff or tobacco cutter.

Cut′ting-file. The toothed cutter of a gear-cutting engine.

Cut′ting-gage. A tool having a lancet-shaped knife (one or two) and a movable *fence* by which the distance of the knife from the edge of the board is

Fig. 1576.



Cutting-Gage

adjusted. It is used for cutting veneers and thin wood. In the West, linn-wood, sawed *through and through* the width of the log, ¼ to ⅜ inch thick, is ripped into plastering-lath by the cutting-gage, after a straight edge has been once established.

Cut′ting-line. (*Printing.*) A line made by printers on a sheet to mark the *off-cut;* that which is cut off the printed sheet, folded separately, and set into the other folded portion.

Cut′ting-ma-chine′. 1. A machine for reducing the length of staple of flax. See BREAKING-MACHINE.

2. A machine for cutting out garments. A reciprocating vertical knife works in a slot of the table which supports the pile of cloth to be cut. The cloth is fed by the attendant so as to bring the line marked on the upper layer in line with the knife.

Cut′ting-nip′pers. A pair of pliers whose jaws are sharp and come in exact apposition. The cutters are sometimes on the face of the jaws and sometimes on the side.

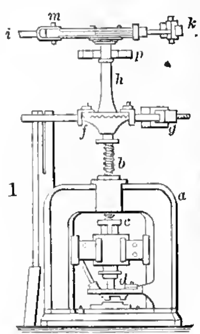
Cut′ting-out Ma-chine′. One by which planchets for coin, or blanks for other purposes, are cut from ribbons of metal. See CUTTING-PRESS.

Cut′ting-plane. A carpenter's smoothing-plane.

Cut′ting-press. 1. A screw-press for cutting planchets of metal from strips. The *cutting-press* of the coining-apparatus (1, Fig. 1577) has a cast-iron frame *a*, which is fixed on a stone basement; *b* is the screw, which is fitted through the top of the frame, and actuates a slider *c*. At the lower end of the slider a steel punch *d* is fixed. Its diameter is exactly equal to that of the pieces which are to be cut out.

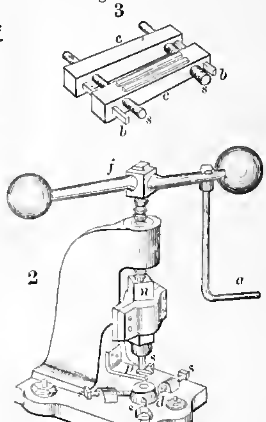
Beneath is the steel die, which has a hole in it of proper size to fit the steel punch. On the other side is a box with screws for adjusting the die, so that the hole in it will be exactly beneath the punch.

Fig. 1577



Cutting-Press.

Fig. 1578.



Cutting-Presses.

The slide *c* is fitted into a socket, which guides it so that it will descend correctly into the hole in the die; a piece of iron is fixed a small distance above the die, and has a hole through it to admit the punch. Its use is to hold down the piece of metal when the punch rises, otherwise the piece would stick to the punch.

On the upper end of the screw, a piece *f* is fixed, and an arm projects from it, with a weight *g* at the end; and it is this weight which gives the necessary momentum to punch out the piece; *h* is a spindle fixed upon the piece *f*, in the line of the screw; it is supported in a collar *p* at the upper end, and above the collar a lever *i m k* is fixed, and at one extremity of this lever a roller *k* is placed; this is acted upon by projecting teeth, which are fixed in the rim of a large horizontal wheel, which is turned round by the prime mover of the mill, and thus produces the requisite motion in the whole apparatus.

2 (Fig. 1578) is a modified form in which *a* is the tail of the weighted swinging-lever *f*, which is moved by hand, to move the slider *n* and the punch. The lower die *d* is adjusted in position by the system of set screws *s*, on the bed-piece; *p* is the holding-down plate.

2. A bookbinder's press (3, Fig. 1578) for hold-

ing a pack of folded sheets while the book is sawed previous to sewing, or for holding the sewed book for edge-cutting. The screws *s s* pass through the side-pieces *c c*, which are steadied by sliding-guides. The pack may now be plowed or saw-cut on the back for the twines to which the sheets are sewed.

Cut'tings. (*Metallurgy.*) The larger and lighter refuse which is detained by the sieve in the *hotching-tub*, or *hutch*.

Cut'ting-shoe. A horseshoe with nails on only one side, for horses that *cut* or *interfere*. A *feather-edge shoe*.

Cut'ting-thrust. A tool like a *cutting-gage*, employed in grooving the sides of boxes, etc. It has a *routing*-cutter in a stock, and an adjustable sliding-head which forms a gage for distance from the guide-edge of the board.

Cut'too-plate. A hood above the nave or hub of a vehicle, to prevent the street mud from falling upon the axle and becoming ground in between the axle-box and spindle. Otherwise called a *dirt-board*, or *round robbin*. It is attached to the axle or bolster.

Cut-vel'vet. (*Fabric.*) Piled goods in which the loops are cut.

Cut-wa'ter. 1. (*Shipwrighting.*) The forward edge of the *stem* or *prow* of a vessel; that which divides the water right and left. It is fayed to the forepart of the stem.

2. (*Bridge.*) The edge of a *starling* presented up stream, to divide the waters on each side of the *pier*.

Cu-vette'. 1. (*Glass.*) A basin for receiving the melted glass after it is refined, and decanting it on to the table to be rolled into a plate.

Fig. 1579.

Cuvette.

The *cuvettes* stand in openings in the sides of the furnace, and are filled with melted glass from the pots by means of iron ladles. The material remains sixteen hours in the pots and sixteen in the *cuvettes*. In casting, the *cuvette* is lifted by means of a gripping-tongs, chains, and a crane, and the contents are poured upon the casting-table.

2. (*Fortification.*) A ditch in the main ditch.

Cy'a-nom'e-ter. Invented by Saussure, for determining the depth of the tint of the atmosphere.

A circular band of thick paper is divided into fifty-one parts, each of which is painted with a different shade of blue; the extremities of the scale being respectively deep blue and nearly white. The colored band is held in the hand of the observer, who observes the particular tint corresponding to the color of the sky. The number of this tint, reckoning from the light end, indicates the intensity of the blue.

Cy-an'o-type. (*Photography.*) A process by Sir John Herschel in which cyanogen is employed. One form of the process is as follows: —

A paper is washed with ferridcyanide of potassium and dried; placed under a frame, the parts exposed to light are changed from yellow to blue (Prussian blue). The picture is washed, then fixed by carbonate of soda, and dried. The picture before washing is lavender on a yellow ground, but washes out to a blue on a white ground. It is rather curious than really useful. The process has several variations.

Cy'clo-graph. More properly ARCOGRAPH (which see).

Cy-cloid'al En'gine. An instrument made use of by engravers in making what is called *machine-work* upon the plates for bank-notes, checks, etc.

The lines have a general *cycloidal* form, being generated by a point revolving around a moving center, or, what amounts to the same, are cut by a graver-point to which a revolution is imparted, the plate traversing below in a straight line, a waved line, a circle, ellipse, or other figure. The line is thus compounded of two movements, and a wavy or complex interlacing figure of absolute regularity is produced as a guard against counterfeiting; it being impossible to produce such work by any means other than such a tool. Counterfeiting, being an underhand proceeding and seeking secrecy, is followed by skillful men, but without the expensive and complicated mechanical adjuncts.

Cy-cloid'al Pad'dle. The name is a misnomer, but is applied to a paddle-wheel in which the board is divided longitudinally into several strips in a slightly retreating order, *en echelon*. The object of the division of the float is to bring the sections in succession into the water, lessening the concussion; and by a more complete distribution of floats around the circumference of the wheel to make the resistance more uniform.

Cyl'in-der. 1. (*Steam-engine.*) That chamber of a steam-engine in which the force of steam is utilized upon the piston.

For more than ten years Watt's conception of the steam-engine could not be realized in practice, owing to the impossibility, with the appliances then at hand, of constructing a piston and cylinder air-tight. Mr. Boulton of Soho came to his relief with capital and mechanical skill.

2. (*Pneumatics.*) The barrel of an air-pump, such as used by Hero of Alexandria (see the *Spiritalia*), and that of Otto Guericke of Magdebourg. See AIR-PUMP.

Perhaps the earliest use of the cylinder and piston is found in the blowing-machines of native metallurgists in portions of Asia and Africa.

3. The *cylinder* of the Jacquard loom is really a square prism revolving on a horizontal axis and receiving the cards.

4. A clothed barrel in a carding-machine. *Urchins* and *doffers* are clothed cylinders of smaller size.

5. The glass barrel of an electrifying-machine.

6. (*Printing.*) *a.* An inking-roller of a printing-machine.

b. The cylinder of some forms of printing-machines carries the type in *turtles*.

7. The bore of a gun. The *charge* cylinder is that occupied by the charge; the *vacant* cylinder is the remaining portion.

8. A wooden bucket in which a cartridge is carried from the magazine to the gun.

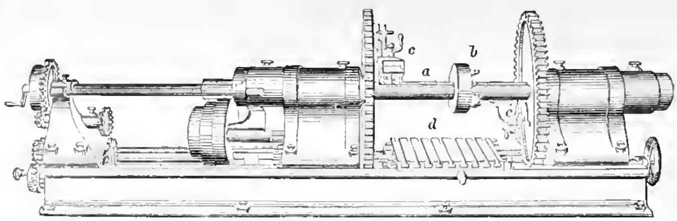
9. The body of a pump.

10. A garden or field roller.

Cyl'in-der-blow'er. A blowing-machine for blast and cupola furnaces, which consists of a piston working in a cylinder. See BLOWER.

Cyl'in-der Bor'ing-ma-chine'. (*Metal-working.*) A machine having face-plates on which the cylinder is dogged concentrically with the axial boring-bar on which a tool-holder has longitudinal feed, to move from end to end of the cylinders. The bar draws entirely out, to allow the work to be shifted, and independent slide-rests face off the ends of the cylinder.

Fig. 1580.



Sellers's Cylinder Boring-Machine.

Cyl'in-der-cock. (*Steam-engine.*) A faucet in the end of a cylinder to allow water of condensation to escape when the piston approaches the said end of the cylinder. Owing to the incompressibility of water, the end of the cylinder may be driven out, if the water be allowed no means of escape. It is also used to allow the passage of steam in blowing through the cylinder, etc., in warming up. It is then, functionally, a blow-through cock.

When the cylinder-cock is made automatic, it has a spring to keep it closed against the normal pressure of steam, but which yields to the excessive pressure in the cylinder incident to the striking of the piston against a body of water, the result of the condensation of steam in the cylinder.

Cyl'in-der-cov'er. (*Steam-engine.*) The lid bolted to a flange round the top of a cylinder, so as to be perfectly steam-tight. The piston-rod passes through a stuffing-box in the center.

The term is also applied to the *jacket*, *lagging*, or *cleading*, which prevents to some extent the radiation of heat.

Cyl'in-der-en'gine. A paper-machine in which the pulp is taken up on a cylinder and delivered in a continuous sheet to the dryers.

Cyl'in-der Es-cape'ment. Another name for the horizontal escapement invented by Graham. See HORIZONTAL ESCAPEMENT.

Cyl'in-der Es-cape'-valve. A valve in the end of a cylinder to let off water of condensation.

Cyl'in-der-glass. A mode of making window-glass, in which the material is brought, by a succession of operations, to the shape of an open-ended cylinder, which is split by a diamond and flatted in a furnace.

Although this plan had long been practiced in Germany and Belgium, it was not imported into England until about 1846, owing to the vexatious excise-regulations, all improvements in glass-working being hampered and well nigh prevented. The imposition, however, was taken off in time for the manufacture of cylinder-glass for the World's Exposition building in London, 1853.

We are not aware that it has yet been introduced into the United States.

As remarked, this mode of making flatted glass was no new thing, but is described in the *Diversarum Artium Schedula*, written probably in the thirteenth century.

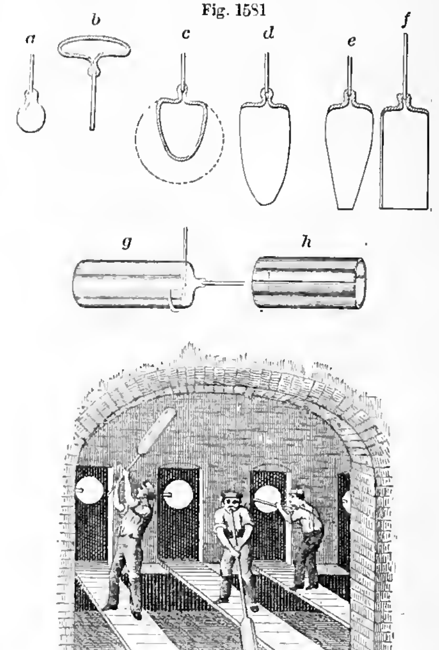
While *crown-glass* is blown into a globe, then whirled and blown into an oblate spheroid, pierced and eventually expanded into a disk, *cylinder-glass* or *broad-glass*, as it is often called, is made into a hollow bulb, which is made gradually to assume the cylindrical form; the ends are opened by means to be described, finally the cylinder is split and flattened.

The process is as follows: —

The workman collects a mass of the glass *a* around the end of his blowing-tube, and then distends and rounds it by blowing and rolling on the *marver*, or flat, cast-iron table. The subsequent operations consist in reheating, blowing, and swinging until the diameter, and then the length of the cylinder required, are attained, the glass successively assuming the forms *b c* represented in the figure. In the fourth stage, where it has assumed a conoidal form *d*, the point is very thin, and the blower, having filled the shell with air at a pressure, places it in the furnace, when the expansion of the air by heat causes the conoid to burst at the apex *e*. The edge of the hole is then trimmed with shears, and enlarged by the *pucellas*, a peculiar hand-tool which resembles a pair of spring sugar-tongs with flat jaws. The cylindrical form *f* being then perfected, the cylinder is ready to be removed from the blowing-tube, a circular piece of glass coming away with the tube so as to make an opening in the other end of the cylinder.

This separation is effected by a red-hot bent iron, in which the cylinder is turned round a few times,

Fig. 1581

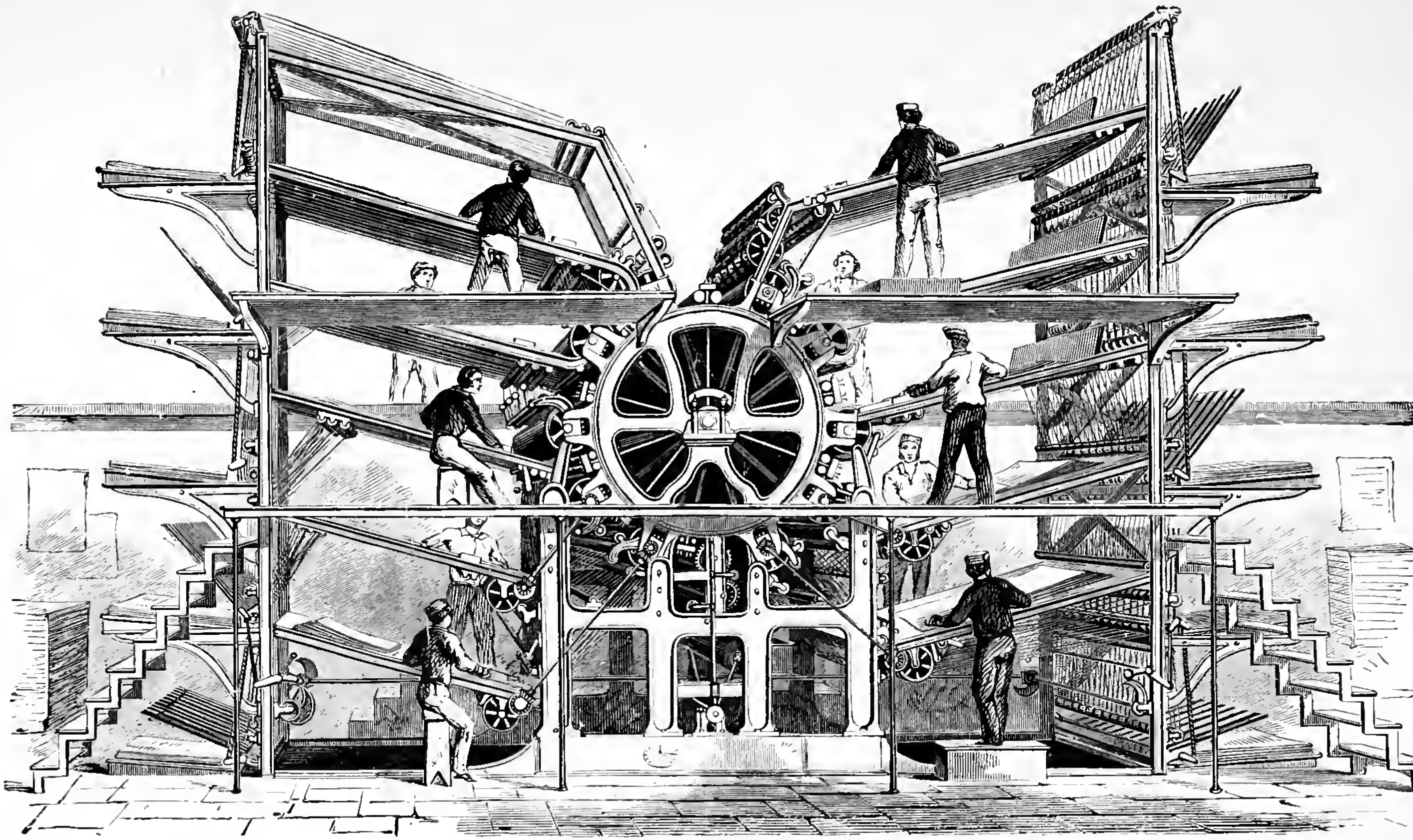


Successive Stages of Cylinder-Glass.

so as to expand the glass at that point *g*. A drop of water on the heated line makes an instant fracture.

The cylinder is then split by a diamond or by means similar to that which removed the disk from the end *h*.

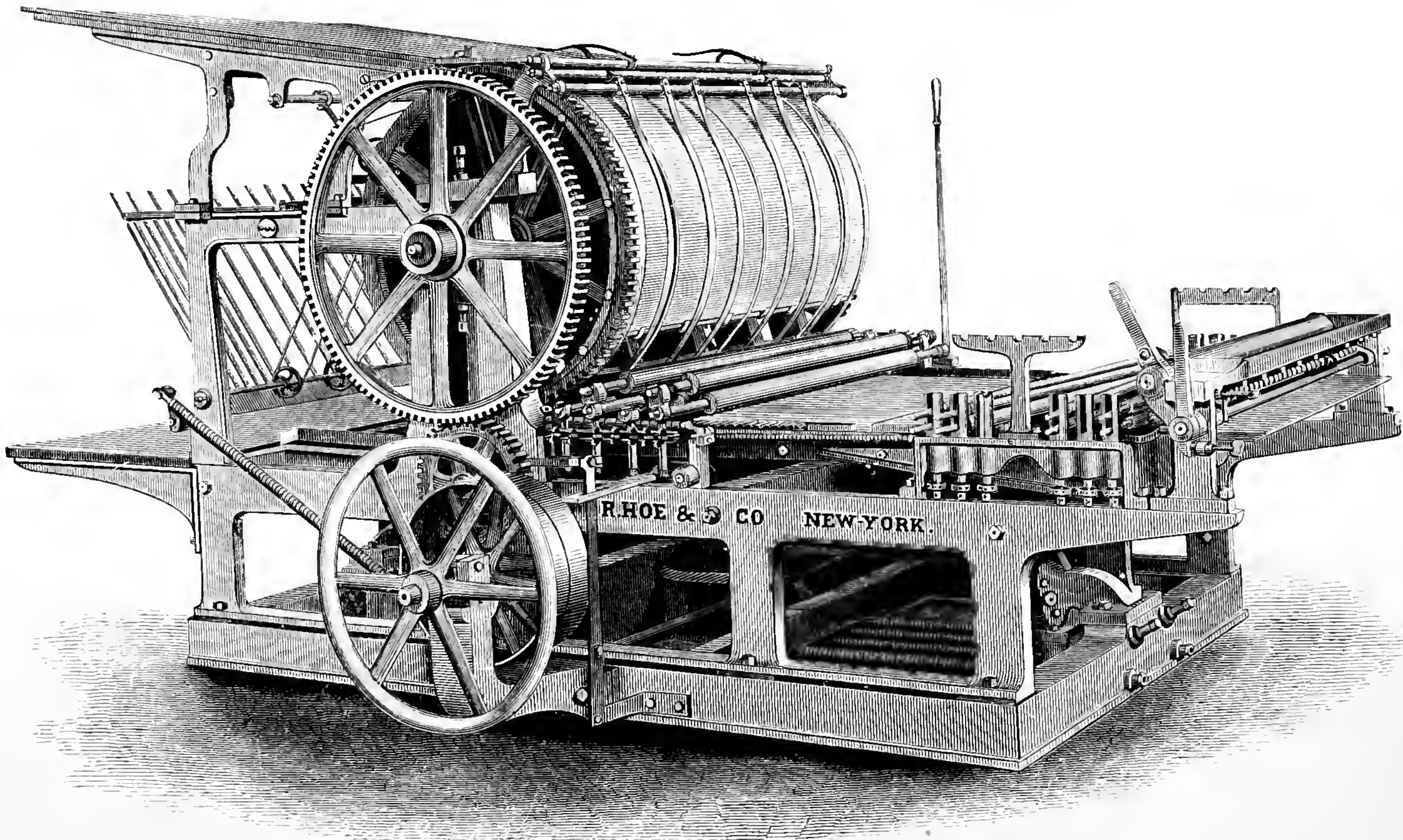
Flatting and *annealing* finish the process. These are accomplished in separate furnaces, or apartments heated by the same furnace. (See FLATTING-FURNACE.) In the combined form it consists of consecutive chambers heated by a furnace beneath. The cylinder is placed on the heated floor of the flatting-furnace, with the cracked side uppermost; the heat



HOE'S TEN-CYLINDER TYPE-REVOLVING PRINTING-MACHINE.

PLATE XI

See page 670.



SINGLE LARGE-CYLINDER FOUR-ROLLER PRINTING-MACHINE.

PLATE XII

See page 671

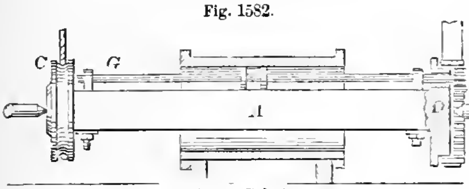
of the furnace causes it to soften and spread out, when all curves and lumps are removed by a straight piece of wood, fastened crosswise at the end of an iron handle and wetted before applying. The flatting-stone is made very smooth, as any inequalities are transferred to the glass. The sheet of glass is then pushed into the annealing-chamber, where it is set upon edge and left to cool gradually.

The operations of making crown and cylinder glass are exceedingly interesting, and have some marked peculiarities. Wonderful is the command attained by skill over the plastic stuff, and in no other art except pottery is there such a growth beneath the hand of the operator.

The illustration shows the men, each on his platform, one swinging his prolonged bulb above his head, another blowing and swinging it below his feet, while a third is observing the operation of heating the glass, which he keeps constantly turning round by means of the rod in his hand, to which it is attached.

Cyl'in-der Grind'ing-ma-chine'. A machine for trueing and polishing the insides of cylinders. The cylinder is secured to the slide-rest, and moves along on the ways longitudinally of the mandrel *A*,

Fig. 1582.



Cylinder-Grinder.

which is mounted on centers, and rotated by the band-wheel *C*. The inside is fixed, and, as the mandrel *A* and head *D* rotate on their axis, the rod *G*, carrying the grinding-disks, is caused to revolve around the said axis, and at the same time rotate on its own axis, carrying the disks.

Cyl'in-der-mill. One form of mill for pulverizing the ingredients of gunpowder, having a cylindrical runner traversing on a bedstone.

Cyl'in-der-pow'der. That of which the charcoal is made in iron cylinders.

Cyl'in-der-press. (*Printing.*) *a.* A form of press in which the type is secured on a cylinder which revolves and presents the form successively to the inking-rollers and to the paper. The *type-revolving printing-machine* of Hoe is of this class, and is shown in the full-page cut opposite. These machines are made with two, four, six, or ten printing-cylinders arranged in planetary form around the periphery of the larger type-carrying cylinder. The type is secured in turtles, or the stereotype is bent to the curve of the cylinder. The circumference of the latter has a series of binary systems, the elements of which are an inking apparatus and an impression apparatus, the paper being fed to the latter, and the printed sheet carried away therefrom by tapes to a flyer, which delivers it on to the table.

b. One in which the form is placed upon a bed and the impression taken by a cylinder, which takes a sheet and receives an impression from the form while it is passing under them. These are known as *double, single, small, large, stop,* cylinder-presses.

In the *double* cylinder-press two cylinders are used, which take sheets alternately. The *single* has but one, and needs but one attendant feeder; the printed sheets are thrown down by a fly-frame.

The accompanying full-page illustration is of a press known distinctively as a *single large cylinder printing-machine,* in which the form runs beneath four rollers. The feed is by fingers on the cylinder, taking sheets from the inclined feed-board above, and passing them between the cylinder blanket and the form, the cylinder and bed-rack gearing together during this portion of the motion of each. The printed sheet is delivered by a flyer.

The *stop-cylinder* press is one in which, after a sheet is printed, the cylinder remains stationary while the bed is running back, during which time a fresh sheet is placed in position.

In the stop-cylinder press, designed for woodcut printing, special arrangements are made for inking, — by a vibrating cylinder or inking-table, as may be desired, — and the number of form-rollers may be proportioned to the character and size of the work, being usually adapted to the size of the bed. The impression-cylinder is stationary during the return of the bed, and the fingers close on the sheet before the register-points are withdrawn; the cylinder then revolves, and it gears directly into the bed, and perfect register is obtained. The bed is arranged to run once, twice, or thrice beneath the inking-rollers to each impression, so as to secure a more perfect distribution of the ink.

Cyl'in-der-print'ing. 1. (*Printing.*) A mode of printing in which the type is secured to the cylinder, or the paper on a cylinder which acts in connection with a rolling-bed. See CYLINDER-PRESS.

2. A system of printing calicoes by engraved copper cylinders, invented in Scotland and perfected in England. These are engraved on the Perkins principle, by which a small roller with the design in cameo is impressed against the surface of the revolving cylinder, delivering upon the latter the design in intaglio as many times repeated as the circumference of the small steel cylinder (the *mill*) is contained in the circumference of the copper cylinder.

This is the principle of the American system of bank-note engraving. See TRANSFERRING-MACHINE.

Cyl'in-der-tape. (*Printing*). A tape running on the impression-cylinder beneath the edge of the paper, to remove the sheet from the cylinder after printing.

Cyl'in-der-wheel. A form of scape-wheel, used in the *horizontal* or *cylinder* escapement.

Cyl'in-der-wrench. A form of wrench adapted to grasp round rods or tubes. See PIPE-WRENCH.

Cy-lin'dri-cal-arch. (*Architecture.*) One which is a prolongation of the same curve throughout its length.

Cy-lin'dri-cal Boil'er. A boiler of a cylindrical shape, in contradistinction to the other and earlier forms.

The cylindrical boiler was introduced into Cornwall, England, in consequence of the use of a higher pressure of steam, which rendered the *haystack, hemispherical,* and *wagon* boilers unsafe. (See CORNISH-BOILER). Smeaton introduced the flue into the boiler. The cylindrical return-flue boiler was patented by Wilkinson in 1799.

Cy-lin'dri-cal Lens. A reading-glass whose back and front faces are formed by cylindrical surfaces, the diameters of which are at right angles to each other: the form being that of two segments of cylinders united at their bases.

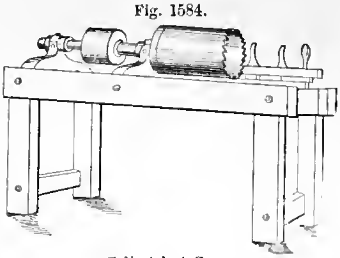
Fig 1583

Cylindrical Lens.

A lens having a cylindrical body and convex ends. A *Stanhope* lens.

The term may also include a lens consisting of a true cylinder which gives a line of light; or of cylindrical segments parallel to each other, which com-

Fig. 1584.



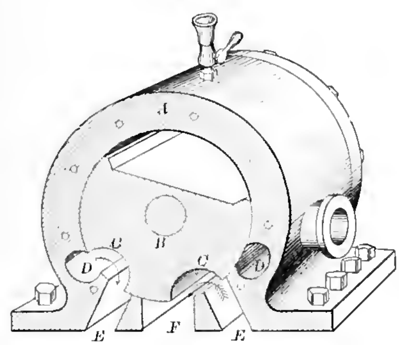
Cylindrical Saw.

bination also gives a line of light.

Cy-lin′dri-cal Saw. A saw having a cylindrical form and sharpened at one end. Used in sawing staves from the block, giving them a transversely rounded form; for sawing felloes, chair-backs, etc. It is on the principle of the crown-saw, and is variously called a *tub-saw*, *drum-saw*, *barrel-saw*, etc.

Cy-lin′dri-cal Valve. (*Steam-engine.*) A valve in a trunnion or elsewhere having a cylindrical shape

Fig. 1585



Cylindrical Valve.

and oscillating on its axis, to open and close ports in the cylindrical case which forms its seat.

Cy′ma Rec′ta. A form of waved or ogee molding hollow in its upper part and swelling below. *Cymatium.* See MOLDING.

The member below the abacus or corona.

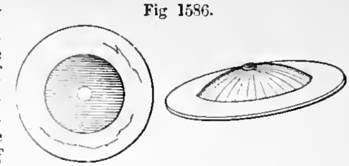
Cy′ma Re-ver′sa. An ogee in which the hollow member of the molding is below. See MOLDING.

Cym′bals. Disks of bronze, more or less basin-shaped, clashed together or lightly touched in accord with the music. They are very ancient, being represented in different forms upon the sepulchral monuments. They were used by the Levites in the temple ordinances, and the sons of Asaph excelled in their use. They are mentioned among other instruments, 1043 B. C., when David brought the ark home, — *harps, psalteries, timbrels, cornets, cymbals* (2 Sam. vi. 5).

The *loud-sounding* and *high-sounding* cymbals mentioned in Psalms cl. 5, were probably the clashing cymbals and rattling castanets.

The accompanying illustration shows the cymbals of ancient Egypt. They have been found in the tombs of Thebes, and those shown are now in the collection of Mr. Salt. They are about 7 inches in diameter, and are of an alloy which does not seem to have been determined analytically. Quite likely they are of bronze, with a possible addition of some silver.

Fig 1586.



Egyptian Cymbals (Salt's Collection).

A small variety of cymbals played with the finger and thumb resemble castanets in the mode of using to beat the measure of the dance. They are shown in the paintings of Herculaneum, and were sometimes attached to the ankles of the flute-players. See CASTANETS.

Cymbals are also represented in the sculptures of Nimroud.

The cymbals were used in religious and patriotic observances by the Egyptians, Assyrians, Jews, Etrurians, Greeks, and Romans; by the Greeks in the worship of Cybele, Bacchus, and Juno; indeed, Xenophon says that the cymbal was invented by Cybele, and used at her feasts, at a period corresponding to our date of 1580 B. C.

The origin of the cymbal was evidently heroic; swords and shields being clashed in the warlike dances of the semi-barbarous people of the countries bordering on the Mediterranean.

In a Persian dance of the times of Cyrus and Cambyses, the movements were performed to the music of the flute, the performers dashing their crescent-shaped shields together, falling on one knee, and rising.

The corybantian dance of Crete and Phrygia was a wild, warlike performance, with the same rattling accompaniment. The Pyrrhic dance, as described by Plato, was a frantic exhibition of evolutions and tumblings, representing the modes of dodging and warding off the blows of swords, daggers, and spears, and was performed to the jarring music of clashing weapons. The modern Greeks, who

"... . have the Pyrrhic dance as yet,"

have emasculated the performance, which threw into the shade anything else on record, including the ferocious and disgusting dances of the redskins of the West.

"My lord called for the lieutenant's cittern, and with two candlesticks with money in them for symbols (*sic*), we made barber's music." — PEPYS, 1660.

Cys′to-tome. (*Surgical.*) An instrument for cutting into a cyst, natural or morbid, such as opening the bladder for the extraction of urinary calculi, opening the capsule of the crystalline lens, etc. *Cystitome.*

D.

Dab. An impression in type-metal of a die in course of sinking.

Dab'ber. 1. (*Printing.*) The original inking-apparatus for a form of type. It consisted of a ball of cloth stuffed with an elastic material. Two of them were used, one in each hand. One of them being dabbed upon the inking-table to gather a quantity of ink, the balls were then rubbed together so as to spread it uniformly. This was done while the *pull* was being made, and when the bed was withdrawn from below the platen, and the printed sheet removed, the assistant, working actively with both hands, inked the surface of the form.

Fig. 1587.

Dabber.

Another form of dabber is a roll of cloth, the end of which is used for inking the engraved copper-plate.

2. (*Engraving.*) A silk ball, stuffed with wool, for spreading the *ground* upon the hot plates.

3. (*Stereotyping.*) In the paper process, the insinuation of the damp paper into the interstices of the letters by dabbing the back of the paper with a hair brush.

The term has also been applied to the cliché process, in which the *form* is dabbed down into a shallow cistern of type-metal which is just setting.

Dab'bing-ma-chine'. (*Type-founding.*) The machine employed in casting large metal type.

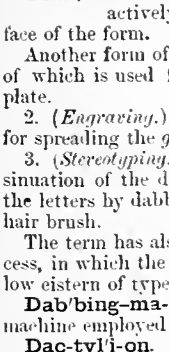
Dac-tyl'i-on. (*Music.*) (*Dactyl*, Gr., a joint.) An instrument invented by Henry Herz for training the fingers and suppling the joints. See Moore's "Encyclopedia of Music." See also CHIROPLAST.

Da'do. (*Architecture.*) A plain flat surface between a base and a cap or corona of a plinth. A *die*.

The space between the base and surbase of a room.

Dag'ger. 1. A weapon with a pointed blade, adapted for stabbing.

Fig. 1588.



Daggers.

The words *dag* and *dagger* came into use about the twelfth century, but the knife is as old as Cain, or Abel it might be said, as he butchered sheep, and brought them and the fat thereof as a sacrifice.

The Romans carried secreted daggers (*dolo*) hidden in the handles of whips and canes.

The Venetians had daggers of glass with three-edged blades and a tube to secrete poison. By a sudden wrench the blade was broken off and remained in the wound, like the arrow-head of an Apache. Nice people both !

The *dagger* was a part of the equipment of the Frank warrior, who probably called it a *coutel*, or something like that. It does not differ materially from the *dirk* (*durk*, *duirc*) of the Gadhelic branches of the Celts, or the *poniard* of those nations who acknowledge Latin (*pungere*, Lat., to prick) as the base of their mother tongues.

In the fourteenth century it was carried by citizens, yeomen, sailors, and ladies. It survives in England in the midshipman's *dirk*, and in other places as a *stiletto*, a *bowie-knife*, etc.

The *dagger* seems to have been a favorite instrument as an accessory to the soldier's equipment for close combat. The Highlander, Western desperado, and Chilian, all seem to approve of the mode of carrying it recorded of Ehud 1336 B. C. : "Ehud made him a dagger which had two edges, of a cubit length, and he did gird it upon his right thigh" (Judges iii. 16). The modern plan seems to be in the garter or the boot, unless it be worn in the belt, bosom, or down the back ; *mirabile dictu*, such was known on the Mississippi and by "Arkansaw travelers."

Some ingenuity has been expended on this weapon in the mode of attaching it to the handle and providing the latter with a pistol.

2. (*Printing.*) A character (†) to call attention in the text to notes on the foot or margin of the page. As a reference-mark it comes next after the star (*).

A double dagger (‡) is another sign for a similar purpose when references are numerous.

Dag'ger-piece. (*Shipbuilding.*) A *diagonal* piece in a ship's frame ; as, *dagger-knee*, *dagger-wood*, etc.

Dag'ger-plank. (*Shipbuilding.*) One of the planks which unite the *poppets* and *stepping-up pieces* of the cradle on which the vessel rests in launching.

Da-guerre'o-type. The photographic process invented by Daguerre during the years 1824–39, resulting in the use of the camera for the exposure of a silver or silvered plate, sensitized by exposure to fumes of iodine in a dark chamber. The latent image was developed by fumes of mercury and fixed by hyposulphite of soda. In 1829, Daguerre was joined in his experiments by Niepce, who had been experimenting for fifteen years with an allied process in which a plate coated with asphaltum was exposed in a camera, the image developed by dissolving away the unalloyed portions by oil of lavender. The French government granted a pension of 6,000 francs to Daguerre, one half to revert to his widow ; 4,000 francs to Niepce's son, with reversion of one half to his widow. Niepce died in 1833, Daguerre in 1851.

Da-guerre'o-type Etch'ing. A mode of etching by means of the influence of light on a prepared plate. The plate becomes exposed where the dark lines of the image fall, and the plate is corroded at those places by a subsequent operation.

Dahl'gren Gun. Named from the late rear-admiral John A. Dahlgren, of the United States navy. A gun in which the front portion is materially lightened and the metal transferred to the rear, giving the "bottle-shape," which caused some surprise on their first appearance in Europe.

Colonel Bomford, chief of ordnance of the United States army, commenced making this experiment previous to the war of 1812, and gave the name of "Columbiad" to the piece.

Da'is. A raised platform at the upper end of a room, of a dining-hall, or room of ceremony. On it the dining-table of celebrities was placed. Its present use is for a throne or rostrum.

Dale. A spout or trough to carry off water ; as a *pump-dale*.

Dam. 1. A bank or structure across the current of a stream.

Dams for reservoirs are among the most important of all embankments, as their failure entails such extensive disasters.

The dam of the Estrecho de Rientes, in Spain, was situated in a valley a little above the town of Lorca, and was designed to hold the water to a hight of 167 feet. After eleven years' use the weight of water, which had attained a hight of 156 feet, April

30, 1802, burst the wall, making a tunnel 100 feet high and 70 feet broad, discharging the whole contents in less than an hour.

The catastrophe was caused by the water finding its way through the sand and gravel at the bottom of the valley.

608 persons were drowned, 809 houses destroyed, and the damage to property was estimated at $700,000.

The thickness of the crown was 36 feet, and the slope of the surface away from the water was 2 feet in hight to 1 base.

The dam of the reservoir of Alicante is circular, the convex side up stream. It is struck with a radius of 350 feet, is 67 feet thick at the top; the masonry batters up stream 10 feet. The thickness at the bottom is 112 feet.

It is executed of a hard primary limestone rock, and the overflow is made in two streams, each 6 feet wide and 7 feet below the crown of the dam, which has an inclination from the surface of the dam of 3 feet 4 inches. Notwithstanding the capacity of the overflow water-way, the reservoir has been several times filled to the level of the top, the water washing over.

On September 8, 1792, after a protracted storm, the water rose to a hight of 8 feet 3 inches above the top of the dam, pouring over it in a magnificent cascade. Such confidence was given by its stability on that and other occasions that the overflows were closed, the waste water tumbling over the wall.

Herrera, the architect of the Escurial, was the author of this magnificent project, which was executed between 1579 and 1594. The depth of water, when full, is 134 feet 6 inches, and the storage capacity 131,000,000 cubic feet.

The Tanks of Ceylon are among the wonders of hydraulic engineering; as, for instance, the chain of tanks which unite the ancient capital Pollinarua with Tamblegam Bay and Trincomalee. Some of these are artificial lakes twenty miles in circumference, formed by embankments of massive masonry that seem to defy the hand of time. They form part of a vast system of irrigation.

Similar structures are found in Southern India and Arabia, and point to the occupation of those countries by the same race; a civilized people, older than the Arabs and Hindoos.

In England the dams of reservoirs are usually earthworks, the dependence for tightness being a *core* or wall of puddle, commencing in a trench below the foundations and carried up to within a few feet of the top. The puddle forms a water-tight wall in the bank, and averages in thickness about one third the hight of the embankment.

The embankment has an internal slope of 1 hight to 3 base; the external slope, 1 hight to 2 base; the width on top, 20 feet.

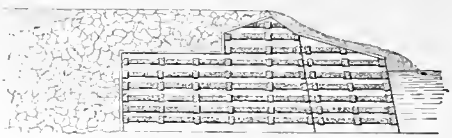
The earthwork is carried up in layers of from 4 to 6 inches, carefully rammed.

In France the main dependence for tightness has been work in hydraulic lime, in the use of which the French workmen are peculiarly skillful.

The French practice has been to carry up the dam in homogeneous layers, not over nine inches thick and rammed to six inches, being watered with lime-water. The *pierre*, or stone pitching of the face, is carried up in independent walls, so that injury to one does not entail the ruin of the rest. The French dispense with the puddle-wall.

The dam across the Schuylkill River at the Fairmount Water-Works, Philadelphia, measures 1,600 feet from bank to bank, forming an angle of about 45° with the direction of the stream. By this extension of length the perpendicular rise above the top of the dam is lessened during high water. The

Fig. 1589.



Overfall Dam across the Schuylkill, Philadelphia.

slack water above the dam extends about six miles, and a canal and locks are provided for overcoming the rise. A part of the bottom consisted of mud, and upon this portion, 270 feet in length, a foundation of rubble was laid, and covered with earth. This portion is 150 feet broad at the base and 12 feet on top, being encased with large stones. The overfall dam is 1,204 feet in length, founded on the bare rock, the deepest portion having a depth of 24 feet below low tides.

While on the subject of dams we must not forget that constructed by Lieutenant-Colonel Bailey to rescue the fleet of gunboats on Red River after the disastrous defeat of the army under General Banks in his ill-starred and worse-managed expedition. As the fleet arrived in the neighborhood of Alexandria it was detained by the low stage of water on the falls at that point. It seemed impossible to escape from the trap, but Colonel Bailey constructed a wing-dam 600 feet in length, which concentrated the flow of water in a narrow channel, and made it possible for the gunboats to float down to the lower level, whence they reached the Mississippi. The operation is termed *flashing*.

2. Of a blast-furnace. See DAM-PLATE; DAM-STONE.

Da-mas'cus-i'ron. Damascus-iron is produced by the following method: —

Unite by welding twenty-five bars of iron and mild steel alternately, each about 2 feet long, 2 inches wide, and $\frac{1}{4}$ inch thick, and having drawn the fagot into a bar $\frac{3}{8}$ inch square, cut it into lengths of 5 or 6 feet. One of these pieces is heated to redness, and one end is held firmly in a vice, while the other is twisted by a wrench or tongs, which shortens the rod to half its length and makes it cylindrical. If two of these twisted pieces are to be welded together, they are turned in diverse directions, one to the right and the other to the left; these are laid parallel to each other, welded and flattened. If three rods be used, the outside ones turn in a direction the opposite of the middle one, and this produces the handsomest figure. By these operations the alternations of iron and steel change places at each half-revolution of the square rod, composed of twenty-five laminæ, the external layers winding round the interior ones; thus forming, when flattened into a ribbon, irregular concentric ovals or circles. The fineness of the Damascus depends upon the number and thickness of the alternations; and the figure of the ribbon, when brought out by acids, resembles that of a curled ostrich feather, but when wound into a spiral form and united on its edge by jumping, the edges bend around, and the figure is completed. Other modes might be mentioned, but all involve the same principles. See WOOTZ.

Da-mas'cus-twist. A kind of gun-barrel made of a ribbon of Damascus-iron coiled around a mandrel and welded. See DAMASCUS-IRON.

Dam'ask. 1. (*Fabric.*) *a.* A rich silk stuff originally made at Damascus and thence deriving its name. It had raised figures in various patterns, and flowers in their natural colors embossed upon a white or colored ground. The work was probably of the nature of embroidery in the first place, but the figures were afterwards exhibited on the surface by a peculiar arrangement of the loom, which brought up certain of the colors and depressed others, according to the requirements of the pattern.

We read of similar goods in the year 1305 B. C., when Deborah celebrated the victory over Sisera: —

"Divers colors of needlework on both sides, meet for the necks of them that take the spoil."

The events of the bloody battle of Mt. Tabor took place but four days' march from Damascus, and it is probable that this ancient city was, as early as the times of Abraham (1996 – 1822 B. C.), the workshop of articles in metal, silk, wool, and flax, as well as the depot of an extensive trade between the Orientals on the east and the Phœnicians, the carriers of antiquity, on the west.

Abraham's steward was a man of Damascus, and, in default of issue, would have been heir to his property. Through all the uproar of antiquity Damascus has maintained a prominent position, being geographically well situated and rich in the great necessity of a warm climate, water.

"Are not Abana and Pharpar, rivers of Damascus, better than all the waters of Israel?" said the haughty Syrian.

Mohammed refused to enter the city, as it was decreed that a man could enter Paradise but once, and he did not wish to exhaust his chances by an entrance on a paradise upon earth.

The steel, the roses, and the fabrics of Damascus survive in most modern languages.

The rich work of the looms of Damascus opened the eyes of the rugged men of the West, who alternately won and lost the rocky mountain-road which led to Jerusalem, and the fabric has retained its name and substantially its character ever since.

Silk and worsted damasks were favorite materials with our grandmothers for bed-hangings, curtains, and the upholstering of furniture.

"A bed of ancient damask."

b. A woven fabric of linen, extensively made in Scotland and Ireland, and used for table-cloths, fine toweling, napkins, etc. By a particular management of the warp-threads in the loom, figures, fruits, and flowers are exhibited on the surface, as in the ancient damask. It is known as *washing* damask, or, when unbleached, as *brown* damask.

A small patterned toweling, known as *diaper*, has a figure produced in the same manner.

c. Stuff with a wavy or watered appearance. *Moire.*

2. (*Metallurgy.*) A wavy pattern shown in articles forged from a combined iron and steel blank. The two metals are mechanically associated, and the bar is then twisted, doubled, welded, or otherwise treated, so as to convolve the fibers of the respective metals. When the forging and grinding (and tempering if a sword) are completed, the article is dipped in acidulated water, which corrodes the steel and does not affect the iron. The steel waves thus appear black, and the iron remains white.

The *damask* is produced by the unequal tendency to oxidation of the two metals.

It must not, however, be supposed that mere ornamentation is the principal object of the mechanical combination of the metals. The main object is quality of the blade or the barrel, as the case may be, and the figure demonstrates visibly the degree and completeness of the association; not intermixture, as the lines of demarcation are well marked, though the laminæ are indissolubly welded.

If the steel be drawn lengthwise, the veins of the pattern will be longitudinal; if the metal be extended equally in different directions, the veins will be crystalline; if it be made wavy in two directions, there will be various shades and gradations, as in the Oriental damask. The orbicular veins or any other pattern is produced by peculiar turns and manipulations, and depends upon the skill of the workman.

Dam'ask-car'pet. Also known as *British*, a damask Venetian. A variety of carpet resembling the Kidderminster in the mode of weaving, but exposing the *warp* instead of the *weft*.

Dam'ask-een. The name is derived from Damascus, where the art is held to have originated.

It means to ornament one metal by another by inlaying or incrustation, as, for instance, a sword-blade of steel, by figures of gold. The metal to be ornamented is carved or etched, and the hollows or lines filled in with the gold or silver, and united by hammering or by solder. It was practiced as early as 617 B. C. by Glaucus of Chios. The analogous operation of inlaying bronze and stones with gold or silver was practiced at remote periods by the Egyptians, as the statues and scarabæi witness. This mode of decoration of metal is principally applied to the ornamentation of swords and other weapons, and has three forms among the Persians, where the art is principally practiced.

a. The design is drawn by a brush, engraved, wires laid in so as to project, and fastened at points by golden nails. The surface of the gold inlay is then engraved.

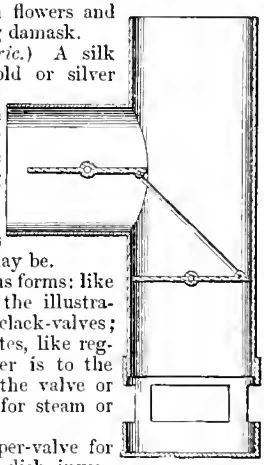
b. The engraved blade is filled even to the surface with gold, which is pressed in and polished by a burnisher of nephrite.

c. The design consists of a great number of minute holes, which are filled with gold-wire burnished in.

Dam'ask-loom. A loom for weaving figured fabrics. See JACQUARD.

Dam'ask-steel. The steel of Damascus originally; the process traveled into Khorassan and Persia, where it prospered long, but decayed as the hordes swept over the country. It is a laminated metal of pure iron and steel, of peculiar quality, produced by careful heating, laborious forging, doubling, and twisting. See DAMASCUS-IRON.

Fig. 1590.



Stove-Pipe Damper.

Da-masse'. (*Fabric.*) A Flanders linen, woven with flowers and figures, and resembling damask.

Dam'as-sin. (*Fabric.*) A silk damask containing gold or silver flowers in the fabric.

Damp'er. 1. A plate in an air-duct, whether air draft or flue, for the purpose of regulating the energy of the fire by regulating the area of the passage of ingress or egress, as the case may be.

Dampers are of various forms: like butterfly-valves, as in the illustration; hinged flaps, like clack-valves; sliding or rotating grates, like registers, etc. The damper is to the air-pipe or flue what the valve or faucet is to the duct for steam or liquids.

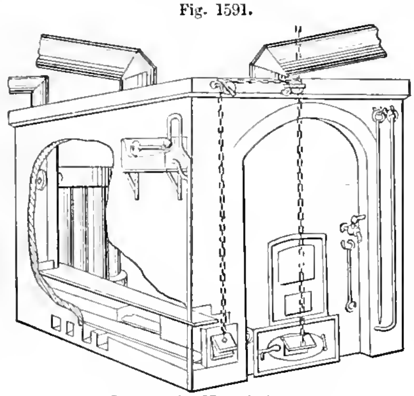
The register or damper-valve for chimneys is an old English invention, and is referred to as such by Savot, in his book, 1624.

The *Laconicum*, or stove of Laconia, used in heating the air of the sweating-apartment of the Roman baths, was heated by the flames of the *hypocaustum* beneath the floor. The heat of the stove was regulated by means of a brazen shield suspended by a chain so as to close entirely or partially the opening of communication between the stove and the basement furnace. In the Baths of Titus a globe attached to a chain acted as a ball-valve in the same manner as a *damper*.

The dampers of furnaces are either in the door of the ash-pit, to regulate the ingress of air, or in the course of or on top of the chimney, to close the egress of the volatile results of combustion. In the latter form they are used in almost all metallurgic furnaces.

In Fig. 1591, the furnace-door and flue-door are respectively furnished with dampers, so connected

Fig. 1591.



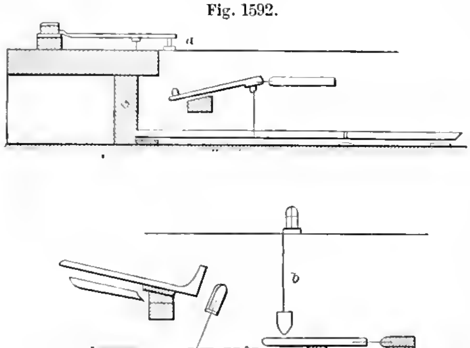
Damper for Hot-Air Furnaces.

that when one is opened the other is closed, and *vice versa*.

2. (*Music.*) A padded finger in a piano movement which comes against the strings and limits the period of the vibrations. Its normal position is upon the string, from whence it is lifted by a wire as the key is depressed by the player.

The damper has assumed various forms: the single action, in which the damper-wire *a* rests on the key;

Fig. 1592.



Damper (Piano-Forte).

the double action, in which the damper-wire *b* rests on a separate lever below.

Bacon says: "In spinets, as soon as the spine is let fall to touch the string, the sound ceases."

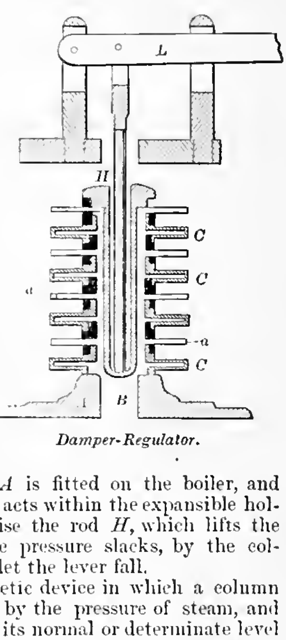
Damp′er-reg′u-la′tor. A device, by which the heat of a furnace or the pressure of steam is made to vary the area of the air-supply opening of the furnace, or of the flue which carries from the furnace the volatile results of combustion.

In the former case the device is thermostatic, usually consisting of a rod or combination of rods, which lengthen or shorten as the heat increases or diminishes above a determinate point; the said variation in length acting mechanically by suitable connections to open or close a damper in the ash-pit door or the flue.

The damper-regulators which act by the pressure of steam are of three or more kinds.

a. A tube is inserted in the top of the boiler, and its open end descends below the water-level. The pressure of the steam supports a column of water in this tube, and the hight of the column varies with the pressure of steam. A float in the tube is supported upon the water; a chain from the float passes over one or more pulleys, and is carried to the damper which is suspended to it. When the pressure of steam is decreased by its withdrawal for the use of the engine or by the slackness of the fire, the column of water descends, bearing the float with it. The float draws upon the chain and raises the damper, so as to allow a greater draft and urge the fire.

Fig. 1593.



Damper-Regulator.

b. A device acting by the direct pressure of steam against a piston or diaphragm, to actuate a lever which will open or close the draft as a greater or less amount of heat is required. The base *A* is fitted on the boiler, and the steam through *B* acts within the expansible hollow disks *C a* to raise the rod *H*, which lifts the lever *L*, or, when the pressure slacks, by the collapse of the disks to let the lever fall.

c. An electro-magnetic device in which a column of mercury is lifted by the pressure of steam, and when above or below its normal or determinate level closes a circuit and brings into action an armature which opens or closes the furnace-door.

Damp′ing-ma-chine′. 1. (*Printing.*) A machine for damping sheets of paper previous to printing. A certain amount of the paper may be thoroughly wetted and built up between dry quires into a pile, by their own weight or pressure causing an equal distribution; or a quire may be quickly passed under water and out again and then built up with others into a pile; or a sparger may be used, as in the perfecting presses which print from a roll, which sends a fine spray upon the paper as it is rolled off from one rod and rolled on to another.

2. A machine in which starched goods are moistened previous to running them through the calendering-machine, to give them a finished and lustrous surface.

Dam-plate. A plate in front of the *dam-stone* which forms the bottom of the hearth in a blast-furnace. See BLAST-FURNACE.

Fig. 1594.

Damping-Machine.

Dam'sel. A projection on a mill-stone spindle for shaking the shoe.

Dam-stone. The stone at the bottom of the *hearth* of a blast-furnace. See BLAST-FURNACE.

Dan. (*Mining.*) A truck or sled used in coal-mines.

Da'na-ide. A water-wheel having a vertical axis and inner and outer drums between which radial floats are attached. The water acts tangentially upon the spirally arranged radial floats, passes down between the said inner and outer cases, and is discharged at the bottom. The water dashes upon the wheel from a chute, and, the floats being spiral, the wheel may be said to act by percussion and recoil. A *tub-wheel.*

Dan'dy. 1. (*Nautical.*) A sloop or cutter with a jigger-mast abaft, on which a mizzen lug-sail is set.

2. (*Paper-making.*) A perforated roller employed to press out the surplus water and *set* the paper. Patented in England by Wilks, in 1830. A partial vacuum is obtained in that part of the roller on which the paper rests.

Dan'dy-brush. A hard, whalebone-bristle brush.

Dan'dy-horse. A velocipede.

Dan'dy-rig Cutter. A peculiarly rigged sloop. See DANDY.

Dan'dy-roll'er. (*Paper.*) A sieve-roller beneath which the web of paper-pulp passes, and by which it is compacted and partially drained of its water. It may be made the means for *water-marking* the paper. The paper passes thence to the first pair of pressing-rollers. A *dandy.*

Dan'iell's Bat'ter-y. The double-fluid battery invented by John Frederick Daniell, F. R. S., who received the Copley medal from the Royal Society in 1837 for this invention; he died in 1845.

A jar of glass or earthenware, in which fits a plate of copper bent into cylindrical form. Within the copper is a porous cup containing the zinc. The liquids used are a saturated solution of sulphate of copper in the outer cell, and of sulphuric acid in the inner cell or porous cup.

To the copper a perforated shelf or jacket is often attached for holding crystals of sulphate of copper, so that the solution may be kept at the point of saturation. See GALVANIC BATTERY.

Dan'ish Bal'ance. A form of the steelyard, the inverse of the Roman or Chinese. The weight and load are suspended at the respective ends, and the suspension-loop is shifted along the beam till equilibrium is attained. The weight of the goods is thus to the weight of the *bob* reciprocally as their respective distance from the loop. (See Fig. 530.)

Dar'by. (*Plastering.*) A float-tool used by plasterers in working on ceilings especially. It is 3½ feet long and 7 inches wide, with two handles on the back by which it is manipulated.

Dark-box. A closed chamber in which an electric light is placed in order that experiments may be deprived of all light except the beams issuing at the lens. See ELECTRIC LIGHT.

Dark-glass'es. Shades fitted to optical reflecting-instruments to intercept the sun's rays.

Dark-lan'tern. A lantern having a circular shade which may be used to close the aperture and hide the light. (See Fig. 972.)

"My father and I with a dark lanthorn, it being now night." — PEPYS'S *Diary*, 1667.

Dark-slide. (*Photography.*) The holder for the sensitized plate. See PLATE-HOLDER.

Dark-well. A cell elevated beneath a transparent object in a microscope, to form an opaque background when the said object is to be viewed as illuminated by light from above.

Darn'ing-last. A potato, an egg, an apple, or a small gourd, to stretch a portion of a stocking while being darned.

Darn'ing-nee'dle. One of large size for carrying a woolen yarn in stopping holes in knitted or woven fabrics.

Dart. A missile spear or javelin much in use among the ancients, and yet seen among many of the more barbarous nations. The Caffres of South Africa and the aboriginal inhabitants of Australia are very expert in the use of the *assegai.* The darts in use among the ancients were of two kinds, namely, spear-headed (that is, without barbs), or bearded. The former were often attached to a long cord, enabling the thrower to recover his weapon after having thrown it. Dart-heads are usually made of iron, but among savage nations flints, sea-shells, fish-bones, and other hard substances, have been employed; and among some of the aboriginal inhabitants of Africa and America the dart was merely a sharp-pointed stick, the end of which was carbonized by fire. The weapon is always very simple in its construction, and is usually from 3 to 5 feet long.

Dash. 1. (*Printing.*) A short line (—) occurring in a sentence to mark a significant pause of more moment than that indicated by a comma.

Also used to indicate a consecutive series, as, John xiv. 1–8. Also used as a "ditto" mark.

The *em-dash* is the length of the "em" of its font; the *en-dash* one half the former. The *double-dash* has the length of two em's.

2. (*Vehicle.*) Formerly *splash-board.* A board or fender erected on the forepart of the bed, and standing in front of the driver. A *dash-board.*

Dash-board. 1. The float of a paddle-wheel.

2. The splash-board of a vehicle.

Dash-pot. A contrivance for easing the fall of a weight. The falling-rod is connected to the piston, and the latter plunges into the water contained in the cylinder. See CUT-OFF (Fig. 1571).

Dash-rule. (*Printing.*) A rule between articles across a column or page, and shorter than the width-measure.

Dash-wheel. (*Bleaching.*) A wheel with compartment revolving partially in a cistern, to wash and rinse calico in the piece, by alternately dipping it in the water and then dashing it from side to side of the compartments as the wheel rotates.

Da-sym'e-ter. An instrument for weighing gases. It consists of a thin glass globe, which is weighed in the gas and then in an atmosphere of known density.

Da'tum-line. (*Engineering.*) The horizontal line of a section from which all hights and depths are calculated.

Daub'ing. 1. (*Currying.*) Or *dubbing.* A mixture of fish-oil and tallow which is worked into leather after the latter has been shaved by the knife at the currier's beam.

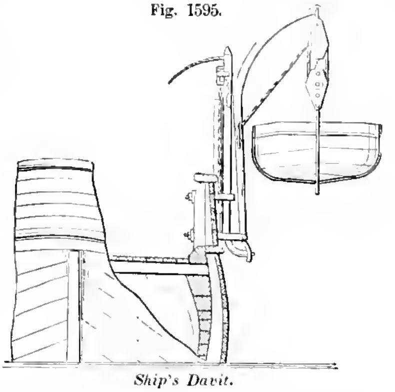
2. (*Plastering.*) *a.* A rough coat of mortar thrown upon a wall, and supposed to give it the appearance of stone. *Rough-cast.*

b. The *chinking* or closing of the apertures between the logs of a cabin. The *daubing* is usually mud. The chimneys, made of sticks, are also *daubed* inside and out.

Dav'it. (*Nautical.*) *a.* A beam projecting from a ship's bow, for the attachment of the tackle whereby the anchor-fluke is lifted without dragging against the side of the vessel. The operation is termed *fishing the anchor.*

b. One of a pair of cranes on the gunwale of a ship, from which are suspended the *quarter* or other

Fig. 1595.

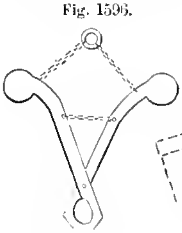


Ship's Davit.

boats. The boat-tackles are attached to rings in the bow and stern of the boat respectively, and the fall is belayed on deck. When the boat is lowered the hooks of the fall-blocks are cast off simultaneously, or great danger results, when the ship is under way. See BOAT-LOWERING APPARATUS, p. 314.

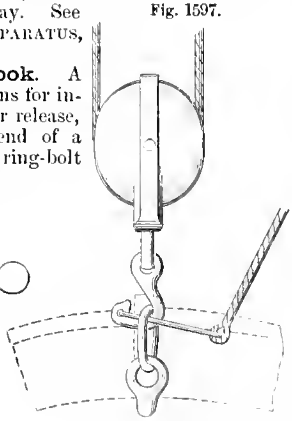
Dav'it-fall Hook. A hook having a means for instant unclutching or release, and used at the end of a davit-fall to engage a ring-bolt at the stem or stern of a boat. See BOAT-DETACHING APPARATUS; DAVIT.

Fig. 1596.



Davit-Fall Hook.

Fig. 1597.



Fall-Block Hook.

In Fig. 1596, the hooked ends are kept together by the suspending-chain, and are opened by their weighted arms as the boat touches the water.

In Fig. 1597, the hook is capsized by a lever and a cord.

Da'vy-lamp. (*Mining.*) The safety-lamp of Sir Humphry Davy, in which a wire-gauze envelope covers the flame-chamber and prevents the passage of flame outward to the explosive atmosphere of the mine, while it allows circulation of air. See SAFETY-LAMP.

Day. The light of a window in a bay; the distance between mullions.

Day-lev'el. (*Mining.*) An *adit*, or *sough.* A drift whose outer end is at the natural surface, open to the day.

D-block. (*Nautical.*) A block bolted to the ship's side in the channels, to reeve the lifts through.

Dead. 1. *Lusterless;* as of some kinds of unpolished or unburnished metallic surfaces. *Matt.* Also of color without brilliancy, as *dead* color. *Destemper.*

2. *False;* as of imitation doors and windows, put in as architectural devices to balance parts.

3. *Motionless;* as the *dead* spindle of a lathe, which does not rotate. A *dead*-lock. *Dead-center* of a crank.

4. *Opaque;* as a *dead*-light or shutter over a cabin window.

5. *Solid, without light or opening;* as a *dead-wall*, a *dead-plate*, or unperforated portion of a furnace-grate; the *dead-wood* of a ship.

6. *Useless;* as *dead steam*, that is, exhausted. *Dead-head*, a *feeding-head* or *sullage-piece.* *Dead-weight.* *Deads* in mining, the useless substances which enclose the ore.

7. *Soundless;* as a *dead-floor*, which absorbs the sound.

8. *Flat;* as a *dead-smooth* file; having the least possible hight of teeth. *Dead-level.*

Dead-an'gle. (*Fortification.*) The space in front of a parapet which is out of view of the soldiers in the work, and which they cannot fire upon.

Dead-ax'le. An axle which runs, but does not communicate motion, as distinguished from a *driving*-axle, which is a *live*-axle.

Dead-beat Es-cape'ment. This, which is also known as the *escapement of repose*, was invented by Graham about 1700, and was intended to isolate the going works more completely from the pendulum. The seconds-hand in the *dead-beat* stands still after each drop, whereas in the *recoil-escapement* there is a *back-lash* to the train.

Fig. 1598.

Dead-Beat Escapement.

The working surfaces of the *pallets* of the *anchor* in this escapement are curved concentrically with the axis of oscillation of the anchor. When a pallet escapes from one tooth and allows a partial rotation of the *scape*-wheel, a tooth on the opposite side is arrested by the other pallet, but without giving any back-lash to the wheel, which would cause a recoil to the train of gearing.

The term *dead-beat* is to contradistinguish it from the *recoil*-escapement (see Fig. 193), in which the working faces are curved eccentrically in relation to their axis of oscillation so as to offer a slight impediment to the motion of the wheel. This impediment causes a slight *recoil* of the *scape-wheel*, which is communicated to the *train*. The pallets in the *recoil*-escapement are both *check* and *impulse*, but in the *dead-beat* one is simply *check* and the other gives a slight *impulse* at the moment of escaping. The impulse given to the pallet is communicated to the pendulum, to overcome the friction on the pendulum bearing and the resistance of the air, and thereby keep the beats of the pendulum isochronous. The *cylinder* or *horizontal* escapement is a *dead-beat* escapement for watches, and was also invented by Graham.

Dead-cen′ter. One of the two points in the orbit of a crank in which it is in line with the connecting-rod. The *dead-point.*

Dead-col′or-ing. (*Painting.*) A first layer of color forming a basis for that which succeeds it. It is called *dead* because it has no gloss, and is to be hidden by the finishing coats. *Destemper.*

Dead-door. (*Shipbuilding.*) One fitted in exterior rabbets, to protect a cabin window or cover an opening when the lights are carried away.

Dead′en-ing. 1. (*Carpentry.*) Packing in a floor, ceiling, or wall, to prevent conduction of sound. Such provision constitutes it a *dead-floor*, or *dead-wall*. *Pugging.*

2. (*Gilding.*) A thin coat of glue, slightly warmed, smeared over a surface that is gilded in destemper, and is not to be burnished.

3. Roughening a surface to diminish the glitter.

Dead-eye. (*Nautical.*) *a.* A block without a sheave, probably so named from a grotesque resemblance to a death's-head or skull. Such are those flat, round blocks fixed in the channels, and having eyes for the lanyards by which the shrouds are set up. The circumferential groove for the shroud is called the *score*. The *dead-eye* is also known as a *ram-block*.

Fig. 1599.

Dead-Eye.

b. The *crow-feet dead-eyes* are cylinders with a number of holes for the lines composing the crow's-foot. A *euphroe* or *uvrow*.

c. The eye-bolt or staple on the gunwale of a canal-boat to which the towing-line is bent. The line is retained by a key of wood, which passes through the eye and is cast loose by pulling out or breaking the key.

Dead-fall. (*Machinery.*) 1. A dumping-platform at the mouth of a mine.

2. A trap in which a falling gate, board, or log drops upon the game and kills it. Used especially for vermin.

Dead-file. One whose cuts are so fine and close that its operations are practically noiseless. See DEAD-SMOOTH FILE.

Dead-flat. The midship bend or frame having the greatest breadth.

Dead-flue. One which is bricked up at bottom and discontinued.

Dead-gold. The unburnished surface of gold or gold-leaf, from the electro bath or the hands of the gilder. Parts of objects are frequently left unburnished as a foil to the brilliant and lustrous burnished portions. Gilders call it *matt*. See GILDING.

Dead-ground. (*Mining.*) A body of non-metalliferous rock dividing a vein, which passes on each side of it. The vein is said to *take horse*, in allusion to its straddling the intervening rock.

Dead-head. 1. (*Ordnance.*) An extra length of metal cast on the muzzle end of a gun in order to contain the dross and porous metal which floats on the sounder metal beneath. When cooled and solid the *dead-head* is cut off.

2. (*Founding.*) That piece on a casting which fills the ingate at which the metal entered the mold. A *feeding-head* or *sullage-piece*.

3. (*Lathe.*) The tail-stock of a lathe containing the *dead-spindle* and *back-center*; in contradistinction to the *live-head* or *head-stock* at the other end of the *sheers*, which contains the *live-spindle*.

4. (*Nautical.*) A block of wood used as an anchor-buoy.

Dead′ing. (*Steam-engine.*) The clothing or jacket around a steam boiler or cylinder to prevent radiation of heat. *Cleading; lagging.*

Dead-latch. A kind of latch whose bolt may be so locked by a detent that it cannot be opened from the inside by the handle or from the outside by the latch-key. The detent is usually capable of locking the bolt in or out, so that the device forms a latch, a dead-lock, or is made inoperative, as desired.

Dead-let′ter. (*Printing.*) Type which has been used for printing, and is ready for distribution. *Dead matter.*

Dead-light. (*Nautical.*) A shutter placed over a cabin window in stormy weather, to defend the glass against the blows of the waves.

Dead-lock. (*Locksmithing.*) A lock operated on one side by a handle and on the other side by a key.

Dead Met′al. Metal, such as gold or silver, left with dead or lusterless, that is, unburnished or unpolished, surface. *Matt.*

Dead-plate. (*Furnace.*) An ungrated portion of a furnace floor, on which coal is *coked* previously to pushing into the fire above the grates. It was introduced by Watt in his patent of 1785.

Dead-point. One of the points at which the crank assumes a position in line with the pitman or the rod which impels it. In steam-engines with vertical cylinders, the *dead-points* are the highest and lowest positions of the crank. A *dead-center.*

Dead-ris′ing. The portion of the ship's bottom formed by the floor timbers.

Deads. (*Mining.*) Non-metalliferous rock excavated around a vein or in forming drifts, levels, shafts, cross-courses, etc. Many veins are too narrow for working, and the walls have then to be cut into to afford space. Such work, as yielding nothing, is called *dead-work* or *tut-work*, and the proceeds are *deads* or *attle*, to be got rid of as economically as possible, by sending up to the surface, or filling up the *gunnies* and *goafs* of old workings.

Dead-sheave. (*Nautical.*) A scored channel for the run of a rope; destitute of a sheave.

Dead-shore. A timber strut worked up in brick-work to support a superincumbent mass, till the brick-work which is to carry it has set or become hard.

Dead-smooth File. A file whose teeth are of the finest and closest quality. The grades are as follows: —

Rough.	Second-cut.
Middle-cut.	Smooth.
Bastard.	Dead-smooth.

The number of the teeth to the inch of a *dead-smooth* file varies with its length in inches.

Inches .	4	6	8	12	16	20
Cuts .	216	144	112	88	76	64

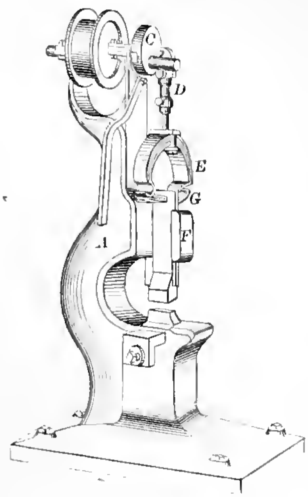
The angle of the chisel in cutting is about 4° from the perpendicular.

Dead-spin′dle. (*Lathe.*) The non-rotating spindle in the *tail-stock* or *dead-head* of a lathe.

Dead-steam. Steam destitute of energy, inactive from want of heat, from having attained its ultimate expansion, or from being so placed as to have no effective value in any given case.

Dead-stroke Ham'mer. A power-hammer which delivers its blow without being affected by the recoil of the shaft on which the ram or hammer is stocked. The frame *A* has a crank-wheel *C* connected by a rod *D* to the spring *E*, from which the hammer is suspended. The latter moves in guides *F*.

Fig. 1600



Dead-Stroke Hammer.

Dead-wall. A wall unrelieved by windows or other openings.

Dead-weight. The weight of the vehicle of any kind; that which must be transported in addition to the *load*. The extent of dead-weight in railway traffic may be judged from the following estimate: —

	Pounds.
Weight of locomotive and tender	104,000
One baggage-car	25,000
Three 56-seat passenger-cars	84,000
One sleeping-car	40,000
	253,000

These cars, if filled, will carry about 194 passengers, which will give 1,304 pounds of dead-weight for each person carried.

Dead-well. A well dug through a stratum impervious to water and penetrating a porous strata; used to allow surface-water to pass away, or to carry off by infiltration refuse water of factories, dye-houses, etc. An *absorbing*-well. See DRAIN-WELL.

Dead-wood. (*Shipbuilding.*) The solid mass of built-up timbers at the narrow portions of the extremities of a ship's frame, fore and aft, above the keel, and continued as high as the *cutting-down-line*. In arctic vessels the *dead-wood* is in unusual quantity, to give solidity to a structure liable to contact with ice-floes and drifts.

Dead-works. The parts of a vessel above the load water-line.

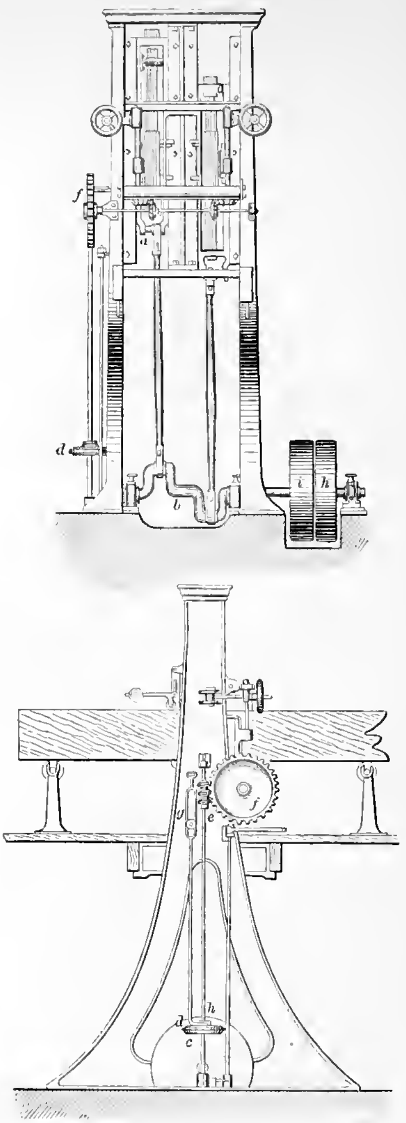
Deal. A plank 12 feet long, 11 inches wide, and 2½ inches thick. Deals are sawed of other sizes, but are reduced to that cubic dimension in computing them.

Practice may differ in different countries. The above is the Ottawa rule. In England, lumber not exceeding 3 inches in thickness and 9 inches wide.

Deal-frame. A *gang-saw* for slitting deals or balks of pine-timber.

The illustration shows the English form of the machine, which has two separate saw-gates *a a*, worked from diametrically opposite cranks on one shaft *b*. The feed is continuous, and the rate of advance adjustable from 18 inches to 72 inches per minute. The feed-motion is by a friction-disk *c*, rod *h*, worm *e*, and wheel *f*, and the rate is adjusted by a lever which raises or lowers the friction-wheel *d* on the disk.

Fig. 1601.



Deal-Frame.

Dèan. (*Mining.*) The end of a level or gallery.

Dear'born. A light four-wheeled family carriage of moderate pretensions and named after the designer.

De-bage'. (*Fabric.*) A dress-goods like alpaca, having a cotton warp and a woolen filling, which is dyed in the wool and mixed in the thread.

De-blai'. (*Fortification.*) The excavated earth which forms the *remblai* or elevated work.

De-bran'ning-ma-chine'. A machine or process for decorticating grain. It is accomplished by steaming and rubbing, by a partial grinding, or by a process equivalent to rasping. See DECORTICATOR.

De'bus-cope. A modification of the kaleidoscope, invented by M. Debus, a French optician.

It consists of two highly polished silvered plates, set at an angle of 70° with each other. When placed before a picture or design, an assemblage of flower petals, or other small colored objects, beautiful designs are formed by their reflected images. The instrument is held stationary while these are copied, and by successively moving it over the object, different combinations of figures are shown, which may be added to the first. It is particularly intended for the use of draftsmen who are required to design ornamental patterns for fabrics.

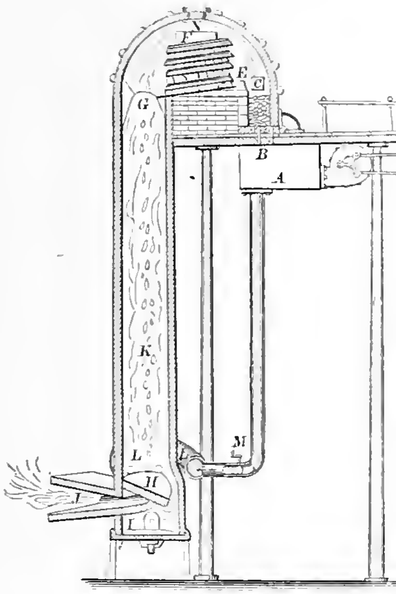
Dec'a-chord'on. An ancient form of harp having ten strings.

De-can-ta'tion. The pouring of a clear liquid from the sediment. In starch-making and operations on a similar scale it is performed by siphons.

De-car'bon-iz'ing-fur'nace. A furnace in which superfluous carbon is burned out of a metal. The term is a very general one, and may include the boiling and puddling furnaces in which cast-iron is heated to make the metal malleable.

Fig. 1602 shows a decarbonizing and desulphurizing furnace in which the air from the blast-wheel is conducted by chamber *A* and tuyeres *B* to the fuel-chamber, whence the flame proceeds to the dome *N*,

Fig. 1602.



Decarbonizing and Desulphurizing Furnace.

and acts upon the pig-iron *F*, which is piled upon the hearth *E*. As the iron melts it runs through the throat *G*, and falls down the shaft *K*, upon the platform *H*, where it rebounds in fine particles, and is exposed to the air from the blast-pipe *L* and its tuyeres, collecting in the hearth *I*. *N* is the charging-hole; *M*, damper; *J*, exit-flue.

Deck. (*Shipbuilding.*) A floor in a ship above the bottom of the hold. Boats have no permanent decks, but are sometimes temporarily covered with a *preventer-deck*.

The deck is said to have been a Thasian invention; first, as a protection to the rowers beneath. In its primary form it was a scaffold, one at the prow and another at the stern, for the combatants.

Decks may run from stem to stern, or be but partial. Some fishing-craft have a partial deck forming a cuddy.

Vessels are classed, for some purposes, by the number of their decks; as, *single-decked*, *two-decked*, *three-decked*.

In three-decked ships the decks above the water-line are known as the *upper* or *spar*, *main*, *middle*, *gun* or *lower* deck. In two-decked ships, the *upper* or *spar*, *main*, and *gun* deck.

In frigates and merchant-vessels, the upper and main decks.

The deck next below the water-line is the *orlop*-deck in two or three deckers, but is known as the lower deck in vessels of the lower grades. The after-part of the *orlop-deck* is the *cock-pit*.

A passage round the *orlop*-deck, to get at the ship's side for repairs during action, is called the *wing-passage*. On this deck are the cabins and berths of officers and men.

A complete deck over the main-deck is the *spar* or *flush* deck.

The *forecastle* is the foremost part, and the *quarter*-deck the aftermost part, of the *spar*-deck; the *waist* is the space amidships.

A small deck at the after end is the *poop* or *round-house*, and usually extends to the mizzen. Above it is the *poop-deck*.

A similar deck at the forward end is called the *topgallant-forecastle*.

A transverse deck extending across the middle of the vessel is called a *hurricane*-deck, *bridge*-deck, or bridge. It is common in steam-vessels, covering the space between the paddle-boxes.

Detached buildings on a deck are *deck-houses*.

The openings in a deck are *ladder-ways* or *hatchways*. *'Tween-decks* is the space below the *spar-deck*.

The former is by a hood or covering called a *companion*. The coverings of a *hatchway* are *hatches*.

The raised ledges around the hatchway are *coamings* in the fore and aft direction; *head-ledges* in the parts athwartships.

Glasses inserted in holes made in a deck are called *deck-lights*, and serve to light cabins below.

Deck-bridge. 1. One in which the track occupies the upper stringer, as distinguished from one in which the track, whether for cars or carriages, rests on the lower stringer and forms a *through* bridge.

2. A platform connecting the paddle-boxes of a side-wheel steamer, or above and across the deck amidships of a propeller.

Deck'el. (*Paper-making.*) A curb, which by confining the pulp determines the width of the sheet or roll of paper. In hand-machines it is a loose rectangular frame of wood.

In machine work it is continuous; usually of linen and caoutchouc along the two margins of the apron. The uncut edge of paper is known as the *deckel* edge.

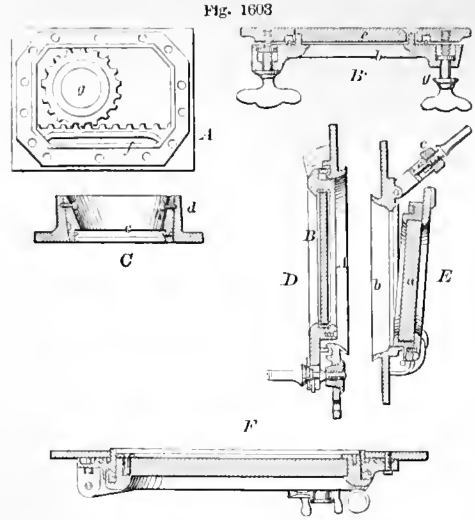
Deck-feed Pump. (*Nautical.*) A hand-pump used for washing decks, feeding the boiler, etc.

Deck-hook. (*Shipbuilding.*) A thwartship-frame crossing the apron in a nearly horizontal position, to strengthen the bow and support the forward end of the deck. See STEM.

Deck-light. A bull's-eye or thick glass window let into an upper deck to light a cabin or stateroom. *Side*-lights are made in a similar manner, and light the staterooms through windows in the side of the vessel.

A has a bull's-eye *g* and a screw-ring which is forced into an elastic packing in the face of the glass, whose frame is rotated by rack *f* as it moves to and from the opening.

Fig. 1603



Deck and Side Lights.

B, a light *c* is held in a frame *b*, which is secured to the post by screws *g*.

C has a light *c* in a bushing *b*, secured in the post-frame *d*.

D has a frame *B* hinged to frame *A*, and secured by a screw.

In *E* the light frame *a* is secured to *b* by hinges and a swinging arm *c*.

F is secured in a somewhat similar manner.

Deck-nail. A diamond-shaped spike for nailing down the deck-planks.

Deck-plate. (*Steam-engine.*) A plate around the chimney of a marine-engine furnace, to keep the same from contact with the wood of the deck.

Deck-stop'per. A cable-stopper on deck, to secure the cable forward of the windlass while it is being overhauled; or one abaft the bitts to keep more cable from running out.

Deck-tran'som. (*Shipbuilding.*) A horizontal timber under a ship's counter.

Dec'li-na'tion. (*Compass.*) The horizontal angle which a needle makes with the meridian. *Variation.*

Dec'li-na'tor. An instrument used in dialing, for taking the declination and inclination of a plane.

De-clin'ing-di'al. One which cuts either the plane of the prime vertical circle or plane of the horizon obliquely.

Dec'li-nom'e-ter. An apparatus for measuring the declination of the magnetic needle; its variation from the true meridian.

De-coc'tion. An aqueous solution of the active principles of any substance, obtained by boiling.

De-clor-im'e-ter. A measurer of the effects of bleaching-powder.

An instrument to test the power of charcoal in its divided state in decolorizing solutions. It is a graduated tube charged with a test solution of indigo or molasses.

De-col'or-ing-style. A method of calico-printing in which the piece of goods is colored, and a part of it — forming a given pattern — is subsequently discharged. Also known as the *discharge-style.* It may be done by printing a dyed piece with something which cancels a portion of the color, or by printing an uncolored piece with a substance which keeps the color from penetrating certain parts. This is called the *resist-style.* By printing certain parts with a mordant, then coloring, a subsequent washing may remove all trace of dye except at the mordanted parts. See CALICO-PRINTING.

De-cor'ti-ca'tor. A process or a machine for removing the hull from grain. In the hominy-mill the fibrous envelope is taken from the corn, which may be left nearly intact otherwise, if desired. The process is sometimes performed by a preliminary steaming, followed by rubbing or rasping. Decorticating was practiced by the Romans, the whole grain being pounded in mortars with some abradant which rasped off the cuticle or bran. Mills for decorticating are known in England as barley-mills, that grain being principally used as human food in the condition known as *pearl* barley. The barley-mill has a roughened exterior, and revolves in a wooden casing. The middle portion of the latter is lined with sheet-iron pierced like a grater with holes, the sharp edges of which turn upward. In Germany grain is decorticated between stones set at such a distance apart as to rasp the bran off the grain without mashing the latter.

Corn is sometimes decorticated by steeping in lye of wood ashes. The *whole* hominy thus obtained is then repeatedly washed to extricate the potash.

A Prussian process is a modification of the centrifugal machine, in which the bran is removed by friction of its kernels irrespective of any artificially prepared abrading surfaces. A vertical casing has a number of horizontal annular shelves, arranged concentrically with an internal cylindrical drum. This latter has radial vanes, which sweep in the spaces between the shelves. A portion of the casing is made of sheet-metal, and perforated in such manner that currents of air, induced in the operation of the machine, pass out from the casing and thence into a dust or bran chamber, and carry with them the dust and bran as fast as they are liberated from the grain. The grain being placed upon the shelves, the rotation of the drum causes its vanes to carry the grain around at the rate of about three thousand feet per minute. The time required to wholly remove the useless envelopes from the kernels is very short, only from three to four minutes, and by ventilating-passages any undue heating is prevented.

De'cus-so'ri-um. An instrument for depressing the *dura mater* after trephining. — THOMAS.

Deeps. (*Nautical.*) The estimated fathoms between the *marks* on the hand lead-line. See MARKS AND DEEPS.

Deep-sea Line. (*Nautical.*) *a.* A water-laid line of 200 fathoms, and used with a 28-pound weight in sounding. It is usually marked as follows in the British service:—

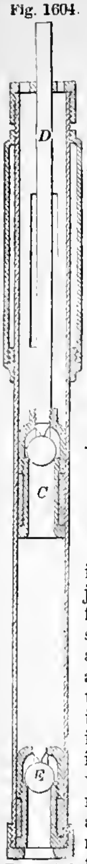
2 and 3 fathoms,		black leather.
5 fathoms,		white bunting.
7	"	red bunting.
10	"	leather with a perforation.
13	"	black leather.
15	"	white bunting.
17	"	red bunting.
20	"	two knots.
30	"	three knots.
40	"	four knots, etc.

A single knot marks the intermediate five fathoms over twenty fathoms.

b. A line for deep-sea fishing. A *cod*-line.

Deep-well Pump. A pump specifically adapted for oil and brine wells which are bored of small diameters and to great depths. From the necessities of the case, the working parts must be contained within a single tube, which has the lower valves

Fig. 1604.

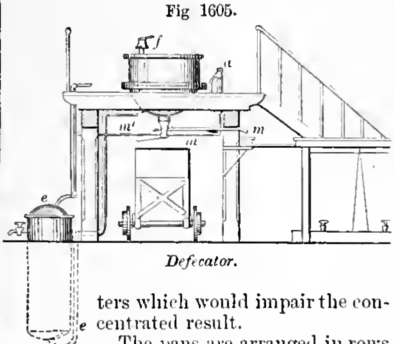


Deep-Well Pump.

and generally a strainer at the foot. Such wells are sometimes 800 feet deep; the tube is in sections united by screw-couplings; the lower end has the foot-valve *E*; the valved bucket *C* is on the end of the long rod *D*, by which the liquid is lifted.

Def′e-ca′tor. (*Sugar-manufacture.*) An apparatus for the removal from a saccharine liquid of the immature and feculent mat-

Fig 1605.



Defecator.

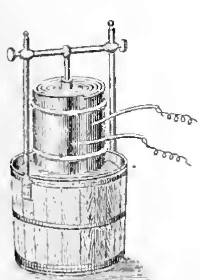
ters which would impair the concentrated result.

The pans are arranged in rows in the sugar-house and heated by steam-jackets. Their use is to clarify the juice from the mill or the partially concentrated syrup from the first vacuum-pan, the acidity in the liquid being neutralized by a portion of lime. A frothy scum rises to the surface, which increases as the liquid is kept in a simmering condition. In the illustration, *f* is the defecator. The juice is received through a pipe from the reservoir *e*, steam from the boilers being admitted by the tube *a*. The scum having attained a considerable solidity, the liquid is withdrawn by turning the handle *m′* of the faucet, allowing the liquid to pass by the pipe *m m* to the trough, which conducts the clarified juice to another reservoir or to the filters.

In other forms, the juice is exposed in a shower to the fumes of sulphurous acid gas, which tends to arrest the fermentation incident to the presence of nitrogeneous matters in the juice. Defecators for sorghum partake of the character of filters, the action being principally mechanical in arresting the floating matters that render the liquid turbid.

De-file′ment. (*Fortification.*) The arrangement of a fortification in regard to the hight of its parapet and direction of its faces, so as to secure it from an enfilading or reverse fire.

Fig. 1606.



Deflagrator.

Defla-gra′tion. The sudden combustion of a substance for the purpose of producing some change in its composition by the joint action of heat and oxygen. It is usually performed by projecting in a red-hot crucible, in small portions at a time, a mixture of about equal parts of the body to be oxidized, and nitrate or chlorate of potash or other energetic oxydizer.

Def′la-gra′tor. An instrument for producing intense heat. It is generally a form of the voltaic battery. Such was used by Davy in 1807–8, when he decomposed soda, potash, borax, and lime.

In the form invented by Dr. Hare of Philadelphia, it is composed of a single sheet each of copper and zinc rolled helically upon a central cylinder of wood. The two metals are prevented from touching each other by intervening pieces of cloth or twine. It is dipped in a tub of acidulated water, and derives its name from its powerful heating effects.

De′flec-tom′e-ter. An instrument for measuring the deflection of a rail by a weight in rapid motion.

De-flect′or. A plate, diaphragm, or cone in a lamp, furnace, or stove, to bring the flame and gases into intimate contact and improve the combustion.

Deg′ging-ma-chine′. (*Cotton.*) One for damping the fabric in the process of calendering.

Dek′le. A curb which determines the margin of the sheet of pulp in hand-made paper.

A strip, sometimes of caoutchouc, lying on the edge of the traveling cloth in a Fourdrinier machine, and forming the edge of the sheet. A *deckle.*

De-laine′. (*Fabric.*) A lady's dress-goods with a cotton chain, woolen filling, untwilled. It is dyed, figured in the loom, or printed.

All-wool delaines are similar, excepting that the chain is of wool.

"The Gauls have a coarse, long-wooled sheep, from which they weave the thick saga called *laines.*"

De′le. (*Printing.*) The expunging term of the proof-reader, marked on the margin.

Delft-blue. (*Calico-printing.*) A mode of printing, also known as *China blue.* See CALICO-PRINTING.

Delft-ware. A kind of pottery originally manufactured at Delft, in Holland, in the fourteenth century. It is now considered coarse, but was among the best of its day, being considered equal to the Italian in quality, but somewhat inferior in its ornamentation.

The glaze of the Delft-ware is made as follows: Kelp and Woolwich sand are calcined together, to form a vitreous mass called *frit.* Lead and tin are calcined to form a gray, powdery oxide. The frit is powdered and mixed with the oxide, zaffre being added to confer blue color, arsenic for dead-white. This is fused, making an opaque enamel; ground and mixed to the consistence of cream.

Delft-ware is made of a calcareous clay of varying color, which is ground in water, strained, and evaporated to a plastic consistence; it is then tempered, and stored in cellars to ripen. Prolonged storage increases its tenacity and plasticity. It is then kneaded, without sand; formed on the wheel, dried, and partially burned, reaching the *biscuit* condition. The bibulous ware is then glazed, dried, packed in *saggars,* which are piled in the kiln and baked.

De-lin′e-a′tor. 1. (*Tailoring.*) A pattern formed by rule; being expansible in the directions where the sizes vary, as indicated by the varying lengths obtained by measurement.

2. (*Surveying.*) A perambulator, or geodetical instrument on wheels, with registering devices for recording distances between points; a pendulum arrangement by which a profile line is inscribed on a traveling strip; and certain other data, according to construction.

De-liv′er-ing-roll. See DELIVERY-ROLLER.

De-liv′e-ry. (*Founding.*) The draft or allowance by which a pattern is made to free itself from close lateral contact with the sand of the mold as it is lifted. Also called *draw-taper.*

De-liv′er-y-roll′er. That roller in a *carding,* *paper, calendering*, or other machine, which conducts the object finally from the operative portions of the apparatus.

De-liv′er-y-valve. That valve through which the discharge of a pumped fluid occurs, as the upper valve of the air-pump in the condensing steam-engine, through which water is lifted into the hot-well.

Delph. (*Hydraulic Engineering.*) The drain on the land side of a sea embankment. It should be at sufficient distance not to encourage the percolation of water from the outside of the bank, or the slipping of the bank from outside pressure. Thirty-six feet from the foot of the bank, 12 feet width at top, 6 feet at bottom, and a depth of 4 or 5 feet, are approved proportionate dimensions.

De Luc's Col′umn. A dry galvanic pile made by alternating plates or sheets, such as silver, zinc, and paper.

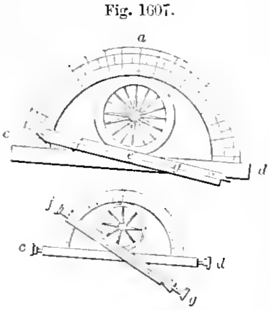
Dem′i-bas′tion. (*Fortification.*) A single face and flank, resembling the half of a bastion.

Dem′i-can′non. An old 33-pounder of 6½ inches bore and a length of 10 or 12 feet. "What's this? a sleeve? 't is like a demi-cannon." — PETRUCHIO.

Dem′i-cap′on-niere. (*Fortification.*) A construction across the ditch having but one parapet and glacis.

Dem′i-cir′cle. An instrument for measuring and indicating angles. It resembles a protractor, and has sights at each end of its diameter, also sights at each end of a rule or alidade *f g*, which has an axis at *e* over the center of the circle, so as to sweep the graduated arc *c a d*. A given object being observed from a station, through the sights *c d*, the alidade is adjusted so that the other object is observable through the sights on *f g*. The point of the rule then indicates the angle. In the middle of the instrument is a compass to show the magnetic bearings.

Fig. 1607.



Demi-Circle.

By providing the instrument with telescopes, a considerable degree of accuracy may be attained, and more distant points conveniently observed.

It is a modest substitute for the theodolite. The plane of the instrument is placed horizontally for taking distances, and vertically for hights.

Dem′i-cul′ver-in. An old 9-pounder, with 4-inch bore and a length of 9 feet.

Dem′i-gorge. (*Fortification.*) The line formed by the prolongation of the curtain to the center of a bastion.

Dem′i-lune. (*Fortification.*) An outwork of the nature of a ravelin.

Dem′i-par′al-lel. (*Fortification.*) Shorter entrenchments thrown up between the main parallels of attack, for the protection of guards of the trenches.

Dem′i-re-lief′. Or demi-rilievo. A term applied to sculpture projecting moderately from the face of a wall; half raised, as if cut in two, and half only fixed to the plane. *Mezzo-riliero.* A degree between *alto* and *basso riliero.*

Dem′i-ri′li-e′vo. See DEMI-RELIEF.

Dem′i-re-vet′ment. (*Fortification.*) A retaining wall for a scarp, covering it as high as protected by the crest of the glacis.

Dem′i-tint. A half-tint or medium shade of color. In studying architectural effects it is observable that the demi-tint is the shade seen when the sun's rays strike the side of a house at a certain angle, say 45°, with the ground plane.

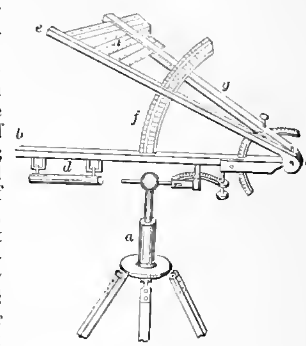
De-my′. A size of drawing and flat writing paper, varying with different makers unfortunately, but quoted by Ringwalt as 16 × 20 or 16 × 21 inches.

Square demy is 17 × 17 inches.

Dem′y-os′tage. A woolen stuff used in Scotland.

Den-drom′e-ter. An instrument for measuring the hight and diameter of trees, to estimate the cubic feet of timber therein. It has means for taking vertical and horizontal angles, and is mounted on a tripod stand. An upright stem rises from the top-plate, at the end of which is a ball, with a hole perforated through it to receive the horizontal stem of the instrument; *b c* may be called the base limb of the instrument, which is brought to an exact horizontal position by means of the level *d*. The limb *c* rises on a joint at *c*, and slides upon a vertical, graduated arc *f*. At the joint *c* is an eye-piece through which the surveyor looks along the side of the bar *b*, to a small point or rising edge at the end of the bar; the part of the tree cut by this line of observation will, if the tree is properly adjusted, be perfectly horizontal with the eye-piece. Another eye-piece is also placed on the upper side of the rising limb, for the purpose of looking along this limb to a point or rising edge *e* in its extremity. The surveyor elevates this limb until that part of the tree to which the measurement is designed to extend is exactly cut by the line of observation, and the angle subtended between that and the horizontal is shown upon the vertical arc *f*. The graduations of the arc *f* are not angles of altitude, but marks or graduations answering to feet and inches of a tangent line, extending from the horizontal point upward, taken at a given distance from the tree; consequently there are two or more rows of divisions, answering to the several distances at which the instrument may be planted. These may be 25 feet and 50 feet, and the graduations made accordingly; the longer distance for larger trees, and the smaller for those of lower stature.

Fig. 1608.



Dendrometer.

The horizontal angles which are to determine the diameter of the trunk, at the several points of observation, are ascertained by the limb *g*, which slides laterally upon an arc or graduated plate *h*, divided upon the same principles as the arc *f*. The limbs *b* or *c* being fixed, so as to coincide with one side of the trunk, the limb *g* is then moved until it coincides with the other side of the trunk, and the angle subtended between the two shows by the graduated plate *h* the diameter in feet and inches of the trunk at the point of observation.

The length of the trunk, and its diameter at the several parts, being thus ascertained by the instrument, recourse must then be had to tables, calculations, or the ordinary sliding rule, for the purpose of obtaining from these measurements the solid contents of the timber in the tree. Adjusting screws, circular racks, and pinions afford means for adjusting the limbs of the instrument, and altering their position, as circumstances may require; and when crooked arms or bent portions of the trunk present themselves, the instrument may be turned upon its pin, in the ball at the top of the stem *a*, and used in an inclined position.

Den'im. (*Fabric.*) A colored, *twilled* cotton cloth used for overalls.

Den'mark-sat'in. A narrow worsted stuff, woven with a satin twill and used for ladies' shoes.

Den'net. A light, open, two-wheeled carriage like a gig, hung by a combination of three springs; two of which are placed across the axle, at right angles with it, the third being suspended from them behind by shackles.

Den-sim'e-ter. An instrument contrived by Colonel Mallet, of the French army, and M. Bianchi, for ascertaining the specific gravity of gunpowder.

It consists of a glass globe having a tube which communicates with a quantity of mercury in an open vessel. The globe is joined at top to a graduated glass tube, which may, by means of a flexible tube, be connected with an air-pump. A diaphragm of chamois skin fits over the lower, and one of wire-cloth over the upper orifice of the globe, and the tubes above and below these orifices are provided with stop-cocks.

For ascertaining the density of the gunpowder, the air is exhausted from the globe by means of the air-pump, until the mercury rises to a certain mark on the graduated tube, when the globe is detached from its support and weighed; it is then emptied and cleaned, and a given weight of gunpowder introduced, when it is again attached to the tubes and the air exhausted as before, filling with mercury all the space in the globe not occupied by the powder, up to the mark before indicated; the stop-cocks are now closed, and the globe once more detached and weighed.

The absolute specific gravity of the powder is obtained by multiplying the weight of the powder contained in the globe by the known specific gravity of mercury, and dividing the product by the product resulting from multiplying the difference between the weight of the globe when filled with mercury alone, and its weight when filled with mercury and powder, into the weight of the powder employed in the experiment.

Dent. 1. (*Weaving.*) One of the *splits* of the *reed*, which is fixed in the swinging lathe, and whose office it is to beat the *weft*-thread up to the *web*.

2. A tooth of a gear-wheel.

3. (*Carding.*) The wire staple that forms the tooth of a card. See CARD.

4. A salient knob or tooth in the works of a lock.

Den'tal Ap'pa-ra'tus and Ap-pli'an-ces. See under the following heads: —

Alveolar forceps.
Amalgam manipulator.
Anæsthetic refrigerator.
Annealing lamp.
Articulator.
Atomizer.
Automatic lamp.
Automatic mallet.
Blow-pipe.
Broach.
Bur.
Bur-drill.
Bur-gage.
Burnisher.
Cow-horn forceps.
Creosote-apparatus.
Dental chair.
Dental chisel.
Dental drill.
Dental files.
Dental hammer.
Dental plugger.
Dental pump.
Dentiscalp.
Dentist's flask.
Denture.
Excavator.
File-carrier.
Filling.
Forceps.
Fulcrum-forceps.
Hoe.
Impression-cup.
Inhaler.
Mallet.
Mouth-glass.
Nerve-instruments.
Nerve-needle.
Nippers.
Nitrous-oxide apparatus.
Pivot-tooth.
Plugger.
Plugging-forceps.
Porte-polisher.
Rubber-gage.
Saliva-pump.
Scaler.
Screw-forceps.
Soldering-lamp.
Spicula-forceps.
Spring for artificial teeth.
Stopping.
Stump-extractor.
Suction-plate.
Tape-carrier.
Thimble.
Tongue-compressor.
Tool-holder.
Tooth. Artificial
Tooth-plugger.
Tooth-saw.
Trephine.
Turnkey.
Vulcanizer.
Vulcanizing-flask.
Wedge-cutter.

Herodotus says that, in the practice of medicine and surgery, the teeth are committed to one set of physicians.

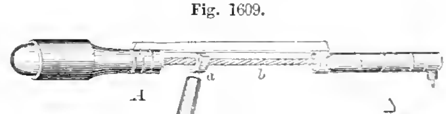
Den'tal Ar-tic'u-la'tor. An instrument for matching the dentures of upper and lower jaw. See ARTICULATOR.

Den'tal Chis'el. For excavating cavities in the teeth or cutting the natural teeth preparatory to filling. They have straight or oblique edges, and are used by a pushing action. Tools of other shapes used by a lateral, rotatory, or drawing action, are EXCAVATORS, DRILLS, BURS, etc. (which see).

Den'tal-cut Dove'tail. A dovetail having a number of dents on each part fitting within the interdental space of the fellow-portions. Drawers and well-constructed boxes are thus secured at their corners.

Den'tal Drill. An instrument for cutting out carious portions of teeth; for opening out a nerve-

Fig. 1609.



Dental Drills.

cavity, for plugging, or for the insertion of a pivot. The drills are sized and shaped for their work.

a, Scranton-drill.
b, square-drill.
c, auger-drill.
d, flat-drill.
e, Forbes-drill.

A is a drill-stock having a nut *a*, traversing on a spiral stem *b*. *B* has a bow *c*, whose string operates the whorl *d* and the tool-socket. *C* has a separate handle and flexible coupling *w*.

Den'tal File. One made for use in operative or mechanical dentistry. Among these may be enumerated the following. Their names are indicative of their purposes.

Biscuspid file.	Molar file.
Feather-edged file.	Plug-finishing file.
Finishing file.	Separating file.
Lateral file.	Stump file.
Knife-edge file.	Vulcanite file.

Den'tal For'ceps. The dentist uses a variety of operating-forceps. Some are distinguished *by their objective names*, as —

Upper forceps.	Molar forceps.
Under forceps.	*Dentes sapientiæ* forceps.
Front forceps.	Root forceps.
Back forceps.	Alveolar forceps.
Incisor forceps.	Spicula forceps.
Bicuspid forceps.	

By shape or peculiar conformation : —

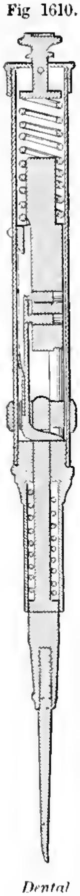
Straight forceps.	Narrow-beak forceps.
Curved forceps.	Cow-horn forceps.
Bayonet-shape forceps.	Fulcrum forceps.
Hawk's-bill forceps.	Screw forceps.

By the kind of duty : —

Excising forceps.	Nipping forceps.
Separating forceps.	Plugging forceps.

Den'tal Ham'mer. An instrument for plugging teeth; operated by the alternate pressure and relaxation of pressure of the stock upon the point. The plugging-tool presses against the filling in the tooth; pressure on the case makes the tool-stock recede, imparting its movement to the lifting-bar and hammer, until the bar passes the incline of the wedge, releases its hold on the catch, and releases the hammer, which descends under the influence of the spring. The force is adjusted by devices operated by an exterior band.

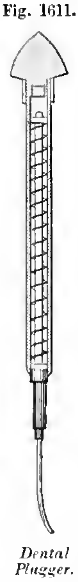
Fig 1610.



Dental Hammer.

Den'tal Plug'ger. An instrument for compacting the metallic filling of teeth.

Fig. 1611.



Dental Plugger.

The point of the plugger continues to press upon the metal in the cavity of the tooth, being actuated by the tension of the spring, while the tube is reciprocated and acts by concussion on the end of the stem.

Den'tal Pump. An apparatus for withdrawing the saliva from the mouth during dental operations. See SALIVA-PUMP.

Den'ted Chis'el. (*Sculpture.*) A chisel with a dentated edge, used in carving stone.

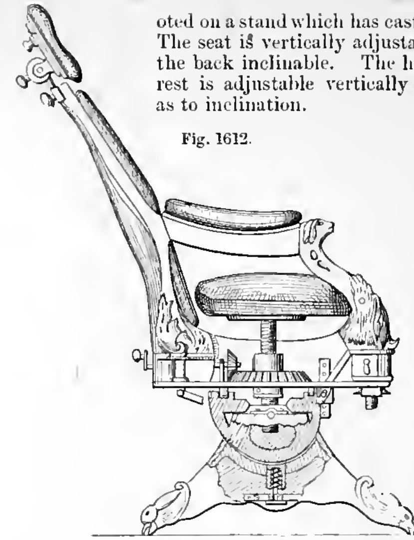
Den-telle'. (*Bookbinding.*) An ornamental tooling resembling notching or lace.

Den'til. (*Architecture.*) A small projecting block in a cornice. Frequently introduced in a row beneath the *corona.*

Den'ti-scalp. An instrument for scaling teeth.

Den'tist's Chair. A chair provided with numerous adjustments to suit the exigencies of surgical dentistry. The chair itself is pivoted on a stand which has casters. The seat is vertically adjustable, the back inclinable. The head-rest is adjustable vertically and as to inclination.

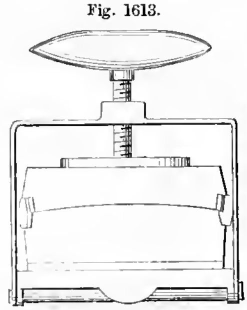
Fig. 1612.



Dentist's Chair.

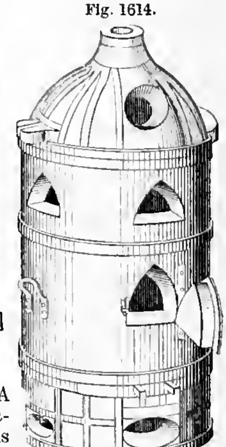
Den'tist's Flask. A case in which a molded vulcanite base for dentures is subjected to the heat of the muffle. A clamp holds the parts of the flask in perfect apposition.

Fig. 1613.



Dentist's Flask.

Fig. 1614.



S. S. White's Dentist's Furnace.

Den'tist's Fur'nace. A furnace for *baking* and *burning* porcelain teeth. It is made of fire-clay, and hooped with sheet-iron. The figure shows the furnace arranged for two muffles. The latter are chambers, like those in an assay-furnace, except that they are destitute of the slots which admit the flame to the contents of the muffle. The lower opening in the furnace is for draft, and leads to the ash-pit.

The opening above, with a door, is that of the principal muffle in which the porcelain teeth are *burned.* In these articles, as in the usual porcelain work, there are several operations. The teeth are molded and then *baked,* which forms them into biscuit. They are then painted with enamel compound, and a second operation, with much increased heat, vitrifies the enamel and completes the operation, which is termed *burning.*

The upper muffle is for *baking* and also for *annealing,* the teeth *burned* in the lower muffle being subjected in the upper one to a lower heat, which is allowed gradually to abate, so that the teeth shall not crack.

The opening in the dome is for fuel, and that in the top for a chimney.

These furnaces are oval in form, with hinged doors, the center sections cased with sheet-iron. The muffles are 12 inches long by $3\frac{3}{4}$ inches wide, inside measurement. The outside measurement of the furnace is 43 inches high, 21 inches wide, and 16 inches deep.

Den'ture. An artificial tooth, block, or set of teeth. The former are *partial* dentures, the latter is a *full* denture.

They may be classified as follows : —

A *pivot-tooth* is an artificial crown set upon a natural root.

Dentures made from *dentine* or river-horse teeth, plate and teeth carved from a solid block.

Plates carved from dentine to fit the gums, or the gums and the roof of the mouth, upon which are pivoted natural human teeth.

Plates made of gold or silver fitted to the mouth and mounted with porcelain teeth.

Continuous-gum dentures. Plates made of platinum and mounted with porcelain teeth, around the necks of which, and upon the lingual surface of the plate, a silicious compound or enamel is fused.

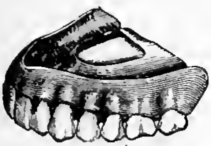
Mineral-plate dentures. Made entirely of porcelain ; plate and teeth molded and carved from porcelain mixture, enameled and burned.

Plates made of *vulcanized rubber* with *porcelain teeth,* secured by being embedded previous to the process of vulcanizing, assisted by pins and staples of platinum.

Plates made by casting a base metal alloy, with porcelain teeth secured by being partially embedded in the casting.

Under the date of March 11, 1664, Pepys writes : "My wife come home, and she had got her tooth new done by La Roche, and are indeed now pretty handsome, and I was much pleased with it."

Fig. 1615.



Denture.

The Japanese *Hadsikfsan,* or "tooth carpenter," is an itinerant artist who makes his teeth of ivory, shark's teeth, or stone, let into the wooden base, and retained in position by being strung on a thread, which is secured at each end by a peg driven into the hole where it makes its exit from the base. Iron or copper tacks are driven into the ridge to serve for masticating purposes, the unequal wear of the wood and metal keeping up the desired roughness of surface. To construct a full upper and lower denture requires about two days' constant work, which becomes five, owing to the frequent chats, naps, and smokes. An impression of the mouth is taken in wax, another impression had from this ; the latter is smeared with red paint, and a wooden block fitted to it by gradual trials and approximations.

Among the technical terms appertaining to dentures are : —

Pivot-tooth, an artificial crown secured to a natural root by the insertion of a pivot, or pin.

Plate-tooth, one fastened to a plate.

Plain-tooth, one without any gum.

Gum-tooth, one made with a portion of gum attached.

Block, two or more teeth made unitedly.

Set, a full furnishing for one jaw.

Base, that which artificial teeth are mounted on or attached to.

Mounting, attaching teeth to a *base.*

De-o'dor-iz'er. A drug or pastille applied to, or burned in the presence of, putrescent, purulent, infectious, or fetid matter.

Deodorizers are a sanitary provision for the defecation of matter having noxious effluvia ; acting to render the matter inert, to absorb it mechanically, or only to disguise it, supplanting the fetor by superior energy, as in the use of aromatic pastilles.

Sanatory experts (L., *sanator,* a healer of diseases, a physician) have devised these *sanitary* expedients (L., *sanitas,* health) to isolate infection and thus prevent the spread of disease. See also DISINFECTOR.

De'phleg-ma'tor. A form of condensing apparatus for stills, consisting of broad sheets of tinned copper soldered together, so as to leave narrow spaces between them.

Dep'i-la'tion. A very good term to describe the process which is usually called *unhairing.* It consists in the loosening and removal of hair from hides and skins, and is usually accomplished by lime. It is hence called *limeing.*

Lime being injurious to leather, other processes have been suggested and to some extent practiced. See UNHAIRING.

De-press'or. (*Surgery.*) An instrument like a curved spatula, used for reducing or pushing into place an obtruding part. Such are used in operations on the skull involving the use of the trephine, and in couching a cataract. Also used in removing beyond the range of the knife or the ligature needle a portion intruding within the area of the operation.

Dep're-ter. Plastering done to represent tooled ashlar-work. It is first pricked up and floated as for *set* or *stucco,* and then small stones are forced on dry from a board.

Depth'en-ing-tool. 1. A countersinker for deepening a hole.

2. A watchmaker's tool for gaging the distances of pivot-holes in movement-plates.

Depth-gage. A graduated measuring-tool, or one capable of being set to a measure to determine the depth of a hole.

Dep'u-ra'tor. An apparatus to assist the expulsion of morbid matter by means of the excretory ducts of the skin. It consists of an apparatus, topical or general, by which the natural pressure of the air is withdrawn from the surface of the body.

The *depurator* is described in Nathan Smith's English patent, 1802. The chamber is filled with steam and the air exhausted to the extent required by the patient, "giving aid to the elastic force of the internal air contained within the human body to throw out the offensive matter."

De-rail'ment. (*Railway Engineering.*) The condition of a locomotive or car in respect of being off the rails.

Der'by. (*Masonry.*) A two-handed float.

Der'mal In'stru-ments. (*Surgery.*) Instruments acting upon the skin, such as the acupuncturator, hypodermic syringe, scarificator, artificial leech, cupping-glass, vacuum apparatus, depurator, etc.

Der'mo-path'ic In'stru-ment. An acicular instrument used to introduce a vesicatory beneath the skin. See ACUPUNCTURATOR ; HYPODERMIC SYRINGE, etc.

Der'rick. A form of hoisting-machine. The peculiar feature of a derrick, which distinguishes it from some other forms of hoisting-machines, is that it has a boom stayed from a central post, which may be anchored, but is usually stayed by guys.

A *derrick* has one leg, a *shears* two, and a *gin* three. A *crane* has a post and *jib.* A *whin* or *whim* has a vertical axis on which a rope winds. The *cap-*

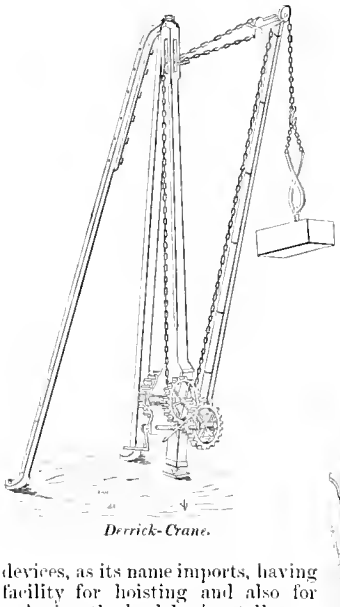
stan has a vertical drum for the rope, and is rotated by *bars*. The *windlass* has a horizontal barrel, and is rotated by *handspikes*. The *winch* has a horizontal barrel, and is frequently the means of winding up the tackle-rope of the derrick; it is rotated by *cranks*. The *crab* is a portable winch and has cranks.

The derrick is more commonly used in the United States than in Europe, and has attained what appears to be maximum effectiveness with a given weight. Two spars, three guys, and two sets of tackle, — one for the jib and one for the load, — complete the apparatus, except the winch, crab, or capstan, for hoisting.

The invention is nautical, the original being the sailor's contrivance, made of a spare topmast or a boom, and the appropriate tackle. Such are used in masting, putting in boilers and engines, and hoisting heavy merchandise on board or ashore.

The *derrick-crane* is a combination of the two devices, as its name imports, having facility for hoisting and also for swinging the load horizontally.

Fig. 1616.



Derrick-Crane.

The machine illustrated was made by Wightman of Edinburgh, Scotland, and consists of a vertical post supported by two timber back-stays whose feet are anchored to the earth. The *jib* or movable spar of the derrick is hinged to and near the foot of the post, its top being held by a chain which passes over pulleys to a winch on the post, so that the inclination of the jib may be adjusted as required. The fall of the hoisting-tackle is passed over a sheave on the summit of the jib, and thence down the jib to the hoisting-winch. This derrick-crane commands a radius of from 10 to 60 feet without being moved from its position.

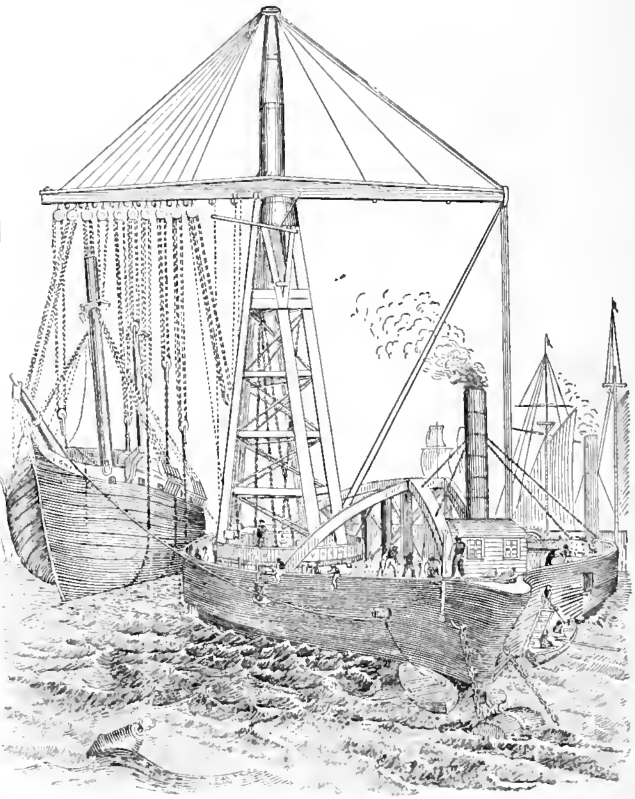
Bishop's floating-derrick was used in 1850 in raising sunken vessels, and consists of a flat-bottomed vessel, 270 feet long and 90 feet beam. It was built by the Thames Iron Shipbuilding Company at Blackwall, and has a number of water-tight compartments, which can be filled, so as to counterbalance any weight on the opposite side. From the deck of this vessel rises an iron tripod, 80 feet high, on the top of which revolves a gigantic boom, 120 feet long, and above the boom the king-post, a continuation of the tripod, rises to the hight of 50 feet.

One arm of the boom is furnished with ten fourfold blocks. The chains attached to these blocks are passed across the king-post, brought over the other arm of the boom, and thence descend to the other side of the vessel, where they are connected to crabs worked by two powerful steam-engines, by means of which the weights are raised.

This floating-derrick is capable of self-propulsion by means of paddle-wheels, and thus removes its suspended load to a position of safety for repair or other purpose.

The present extensive use of horse hay-forks for hoisting hay in stacking or mowing has given rise to a number of inventions for obtaining an elevated point of support for the upper pulley.

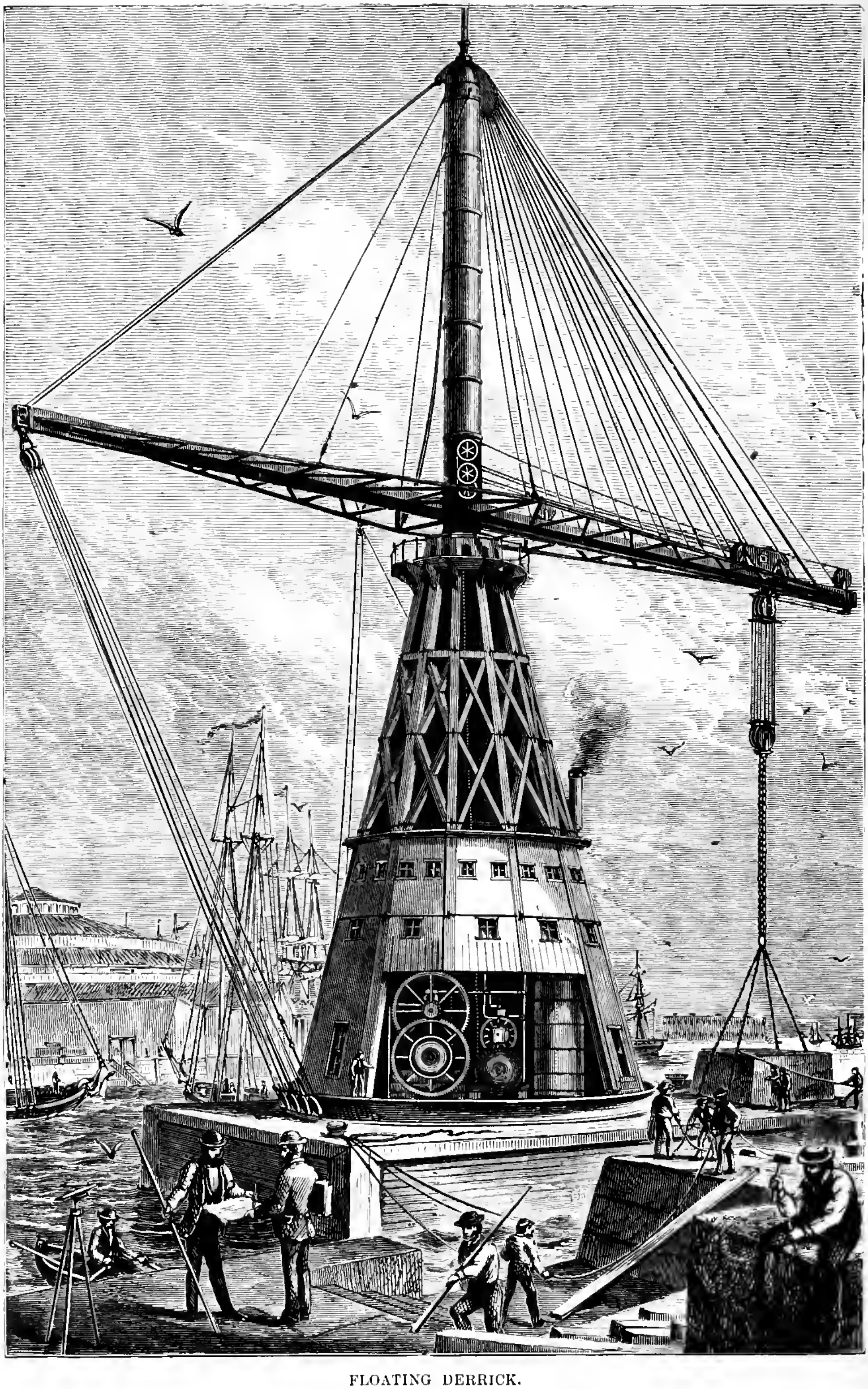
Fig. 1617.



Bishop's Floating-Derrick

Some of these are on portable frames, or wagon-bodies. Others are true *derricks*, with a jib or spar stayed by guys. Some more nearly resemble the *crane*, others the *gin*. Many minor peculiarities distinguish them, but in their general features their construction is fairly referable to those described under the various heads.

The floating-derrick of the New York Department of Docks was built under the supervision of Mr. Newton, assistant-engineer of the department. It was constructed expressly for the purpose of trans-



FLOATING DERRICK.

PLATE XIII NEW YORK DEPARTMENT OF PUBLIC WORKS. See page 689.

porting from the work-yards the blocks of granite and artificial stone that are to form the river-wall. Its lifting and carrying power is 100 tons, and the float which carries the derrick is of rectangular form, 66 by 71 feet, and 13 feet in depth. It is stiffened by sixteen trusses, extending from the deck to the bottom, and running across from side to side.

The tower, which is placed upon the float, and supports the king-post and booms, is made of twelve balks of pine, 63 feet 3 inches in length, and 14 inches square. These balks or legs are stiffened from one end to the other by struts and braces; their lower ends are bolted into a heavy cast-iron circle, which, in its turn, is held down by numerous bolts which pass through the bottom of the floor. At their upper extremity these legs are brought close together, and are inserted in a cast-iron cap, to which they are bolted. The tower forms a frustum of a dodecagonal pyramid 40 feet in diameter at the base, 52 feet in hight, and 12 in diameter at the top.

The front or hoisting boom of the derrick consists of two wrought-iron box-girders 22 inches deep by 9$\frac{3}{4}$ inches wide. These girders are made of planed plates, are spaced 24 inches asunder, and are held parallel by braces of wrought-iron; on the upper and inner edges of these girders a track or slide of polished brass is fastened by counter-screws. These tracks have a projector which extends a short distance downward; the carriage which carries the main hoisting-blocks slides on them. The carriage is composed of two plates of iron $\frac{3}{4}$ of an inch thick, and spaced 10 inches asunder; its length is 8 feet, its depth 3 feet. The iron boom is supported by eighteen diagonal rods 2$\frac{1}{2}$ inches in diameter. These converge near the top of the king-post, and are secured to it by three heavy forgings, which straddle the iron cap on the top of the post.

The king-post is of wrought-iron, 40 inches outside diameter. It is hollow, and its shell is $\frac{3}{4}$ of an inch thick. It revolves in a circular casting, swinging the boom completely around.

All the machinery is placed on the float under the tower, and the levers which operate it and give the various movements are brought together on a platform 35 feet above the deck of the float, so that the person operating them acts in full view of the load that is being handled. (See plate opposite.)

De-scend'ing-let'ter. (*Printing.*) One of those which descend below the line, as *f, g, j, p, q, y*.

Des'ic-ca'tion. The evaporation or drying off of the aqueous portion of bodies; practiced with fruit, meat, milk, vegetable extracts, and many other matters. It is usually done by a current of heated, dry air, and as such may be considered as distinguished from evaporators, so called, to which furnace heat or steam heat is applied.

De-sil'ver-ing. The process of removing lead from an alloy with silver by means of removing crystals of the former from the cooling alloy. The Pattinson process.

Desk. A sloping table, frame, or case for a writer or reader. In the illustration are several forms of school-desks.

A shows a desk with a seat for the scholars in the row in front of it. A single seat is required for the rear row.

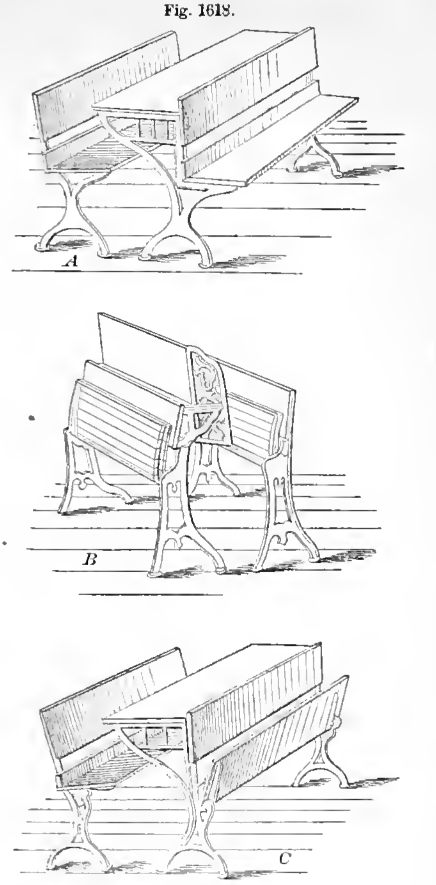
B shows a desk and seat capable of folding for transportation and for sweeping.

C, the seat only folds.

Desk-knife. An *eraser*.

Des-tem'per. A mode of painting with opaque colors, principally used for walls, ceilings, domes, scenes, etc., in which the colors are mixed with chalk or clay and diluted with size. *Tempera*

Fig. 1618.



School-Desks.

painting was practiced in ancient Egypt. The wall was covered with a coating of lime or gypsum. The outline was sketched in with red chalk and then filled out with black. The painter levigated his colors and mixed them with water, placed them on a palette hung to his wrist, and applied them to the surface on which he was at work.

It was also practiced in Greece and Rome. The cartoons of Raphael are in destemper. It is common for auditoriums. Kalsomine (or calcimine) is a form of it. Sometimes written *distemper* or *tempera*.

De-sul'phur-iz'ing Fur'nace. (*Metallurgy.*) A roasting-furnace for driving off the sulphur from pyritic ores. There are many forms adapted to the requirements of different ores, facilities of building, kind of fuel, and the more or less perfect result demanded by the value of the metal and other commercial and economical incidents.

Ores are desulphurized by roasting in heaps.

In reverberatory furnaces of the usual kind. See COPPER-FURNACE.

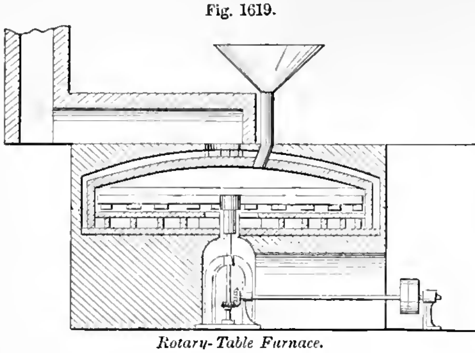
In rotary inclined cylinders exposed to the heat of a fire beneath.

In a flue or stack where it falls through a column of flame. See DECARBONIZING-FURNACE.

On a rotary-table furnace (as in Fig. 1619), where the desulphurizing-chamber is surrounded with flues through which the caloric currents from the furnace are compelled to pass on their way to the chimney.

Within the chamber is a stirrer provided with conveyors and operated by gear-wheels. The pulverized

Fig. 1619.

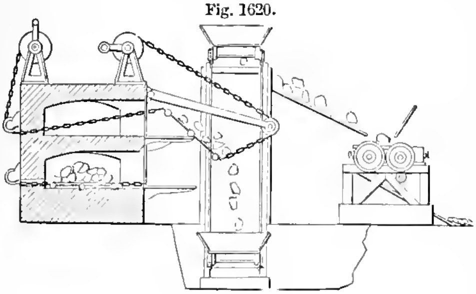


Rotary-Table Furnace.

ore is placed in the center of the oven, and carried by the conveyor to the discharge-hole near the outside.

Another form is that in which the ore is placed on movable plates, and, when heated to redness, is drawn

Fig. 1620.



Desulphurizing-Furnace

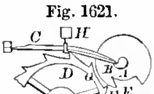
out of the furnace by the chains, and dumped into water. When removed from water, it is crushed before passing to the cupola.

In Hagan's process, superheated steam is introduced into the furnace and decomposed, the hydrogen flame attacking the sulphur, arsenic, and antimony.

De-tached' Es-cape'ment. The detached escapement was invented by Mudge in the seventeenth century.

Earnshaw's detached escapement has two vibrations of the balance for each impulse, resembling the duplex in this respect. *A* is the main pallet projecting from the balance-arbor, concentric with which is another small pallet, called the *lifting-*pallet, which, when the balance is vibrating from *A* towards *B*, lifts a very slender spring *B*, and with it the detent-spring *C*, so as to set at liberty or unlock the tooth *D*, the point of which rests on a ruby pin projecting from the detent-spring *C*, and forming the detent.

Fig. 1621.



Detached Escapement.

The point *E* of the principal pallet having passed the tooth *F*, the wheel moves forward by the action of the mainspring, while the next tooth *G* falls upon the ruby pin and is locked. The screw *H* serves to adjust the position of the detent and the strength of the locking. In the return of the balance, the pallet *A* passes easily by the detent-spring by forcing back the slender spring *B*.

This is a chronometer escapement.

The term *detached* is also applied to the ordinary form of lever-escapement with two pallets, which engage the teeth of the scape-wheel, and a fork which engages a pin on the balance-arbor. The term *detached*, in this case, is to distinguish it from the *anchor*-escapement, wherein a segment-rack engages a pinion on the balance-arbor. See LEVER-ESCAPEMENT.

De-tached' Work. (*Fortification.*) A work included in the defence, but placed outside the body of the place.

De-tach'ing Horses from Car'riages. A means for suddenly releasing an unmanageable team from the vehicle.

The Marquis of Worcester, in his "Century of Inventions," 1655, describes an apparatus of this kind, under command of the passengers, in which, "by means of a T-ended lever, two or four bolts could be simultaneously drawn inwards, and the horses thereby released with the greatest possible ease and certainty."

Hohlfield of Saxony, 1711 – 71, contrived a carriage in which the person could by a single push loosen the pole and set the horses at liberty.

Williams's English patent, 1802, operates by a cord releasing a bolt, which allows the studs to which the traces are attached to rotate and the traces to slip off.

Since these, numerous devices have been suggested, but have not come extensively into use.

De-tect'or. 1. An arrangement in a lock, introduced by Ruxton, by which an over-lifted tumbler is caught by detent, so as to indicate that the lock has been tampered with.

In Mitchell and Lawton's lock, English, 1815, the motion of the key throws out a number of wards, which engage the key and keep it from being withdrawn until the bolt is moved, when the pieces resume their normal position and release the key. Should the key fail to act upon the bolt, it cannot be withdrawn, but the lock must be destroyed to release it.

Chubb had a *detector* in his lock of 1818.

2. A means of indicating that the water in a boiler has sunk below the point of safety. See LOW-WATER DETECTOR.

De-tent'. A pin, stud, or lever forming a stop in a watch, clock, tumbler-lock, or other machine. It is variously called in specific cases; as, *click*, *pawl*, *dog*, *fence*, etc. It is usually capable of motion, either at certain intervals, as in some escapements, or by operation of a key, as in locks.

A detent-catch falls into the striking-wheel of a clock, and stops it from striking more than the right number of times. The watch-escapement has also a *detent.*

The ratchet-wheel has a *click*, to prevent back motion.

The windlass has a *pawl*, to fall into the notches of the rim.

Det'on-at'ing-ham'mer. The hammer of a percussion gun-lock.

Det'on-at'ing-pow'der. One which explodes by a blow. The compound used in the priming of percussion-caps and fuses is the fulminate of mercury or of silver, collected as a precipitate when the metal, dissolved in nitric acid, is poured into warm alcohol. The precipitate is collected, washed, and dried.

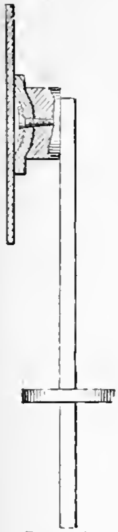
Det'on-at'ing-pri'mer. (*Blasting.*) A primer exploded by a fuse, and used in blasting operations to violently explode gun-cotton, instead of the former plan by which the charge of gun-cotton was simply ignited.

Det′o-nat′ing-tube. A graduated tube used for the detonation of gases, being pierced by two opposed wires by which an electric spark is introduced. The gas is confined over water or mercury. See EUDIOMETER.

Det′o-na′tion. Instantaneous combustion with loud explosion.

De-vel′op-ing. (*Photography.*) The treatment of an exposed sensitive photographic surface with a solution of a protosalt of iron (generally sulphate of iron), pyrogallic acid, or gallic acid, in conjunction with a small amount of nitrate of silver, either present in the film or added, so as to call into visible existence the latent picture produced in the camera or under a negative; an operation always performed in an actinically dark room, that is, one in which the rays at the violet end of the spectrum are excluded.

Fig. 1622.



Developing Stick.

The developing-stick has a suction-pad of india-rubber, by which it is made to cling to the glass, allowing great freedom of motion without danger of becoming detached.

De-vel′op-ment. (*Shipbuilding.*) The process of drawing the figures which given lines on a curved surface would assume, if that surface were a flexible sheet and were spread out flat upon a plane without alteration of area and without distortion.

Surfaces not truly developable are drafted on a plane surface by the process termed EXPANSION (which see).

De-ver′soir. (*Hydraulic Engineering.*) Of a dike, the fall.

Dev′il. 1. A machine for opening out the tussocks of cotton, and cleaning therefrom the dirt and offal. It has various other names, such as *willower*, *willy*, *beating-machine*, etc. See COTTON-CLEANING MACHINE.

2. A rag-engine or spiked mill for tearing woolen rags into shoddy, or linen and cotton rags to make paper pulp.

3. A machine for making wood screws.

Dev′il-car′riage. A carriage used for moving heavy ordnance. A *sling-cart.*

Dev′il's Claw. A grapnel.

Dew-point. The point of temperature at which the moisture of the air commences to condense. See HYGROMETER.

Dew-ret′ting. The process of softening and removing the mucilage from the fibrous and cellular portions of the stalks of flax and hemp, by exposure to *dew*, showers, sun, and air upon a sward. See RETTING.

Dex′trine. A gummy material made from starch and largely used in the manufacture of calico. Its name is derived from its right-handed rotation of a ray of plane polarized light.

Torrefied starch; roasted at a temperature of 300° F. *British gum.*

Potato starch moistened with water, acidulated by nitric acid, dried spontaneously and then in a stove at 212° F.

Dho′ney. A native coasting-vessel of India with two masts and not exceeding 150 tons.

Dhow. An Arab vessel with a single mast, a yard the length of the vessel, and a lateen sail. They are from 150 to 200 tons burden.

Di′a-caus′tic. A double-convex lens used in cauterizing parts of the body.

Di-ær′e-sis. (*Printing.*) A mark (¨) placed over the second of two adjacent vowels to indicate that they should both be pronounced; as, *aërated.*

Di′a-gom′e-ter. An electroscope invented by Rousseau, in which the dry pile is employed to measure the amount of electricity transmitted by different bodies; to determine their conductivity.

Di-ag′o-nal. (*Shipbuilding.*) 1. A timber brace, knee, plank, truss, etc., crossing a vessel's timbers obliquely.

2. A line cutting the body-plan diagonally from the timbers to the middle line.

3. An oblique brace or stay connecting the horizontal and vertical members of a truss or frame.

Di-ag′o-nal-built. (*Shipbuilding.*) A manner of boat-building in which the outer skin consists of two layers of planking making angles of about 45° with the keel in opposite directions.

They are built, like clinker-built boats, upon temporary transverse molds. After setting up and fixing the molds upon the keel, the gunwale, a shelf-piece, and a series of rib-bands are temporarily fixed in the molds. Two layers of planking are then put on, bent to fit the molds and rib-bands, and fastened to each other and to the keel, stem, stern-post, shelf, and gunwale with nails, driven from the outside, and clenched inside upon small rings, called *roves.* The gunwale is then shored, to keep it in shape. The molds and rib-bands are taken out, and floors, hook, thwarts, etc., are put in as in a *clinker-built* boat.

Di-ag′o-nal Eye-piece. Used for solar observations. A very small percentage of the sun's light and heat is reflected from the first surface of a prism, the rest being transmitted.

Di-ag′o-nal Fram′ing and Stays. (*Steam-engine.*) The oblique frame and braces which connect the plumber-block of the paddle-shaft with the framing of the side-lever steam-engine.

Di-ag′o-nal Lines. (*Shipbuilding.*) Lines showing the boundaries of various parts, formed by sections which are oblique to the vertical longitudinal plane, and which intersect that plane in straight lines parallel to the keel. Usually drawn in *red* in the draft.

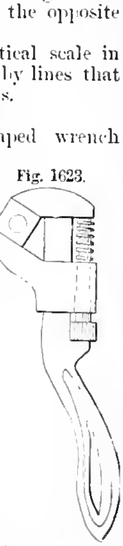
Di-ag′o-nal Rib. A projecting band of stone or timber passing diagonally from one angle of a vaulted ceiling across the center to the opposite angle.

Di-ag′o-nal Scale. A mathematical scale in which the smaller divisions are made by lines that run obliquely across the larger divisions.

Di-ag′o-nal Tie. An angle-brace.

Di-ag′o-nal Wrench. An S-shaped wrench adapted to be used in corners where the ordinary wrench will not turn.

Fig. 1623.



Diagonal Wrench.

Di′al. 1. An instrument for showing the time of day by the sun's shadow.

Since man first looked up and regarded the sun, its apparent diurnal course has been the measure of time as to parts of days, as the recurrences of his visits have formed the units of the still greater period which marks his complete circuit in the zodiac.

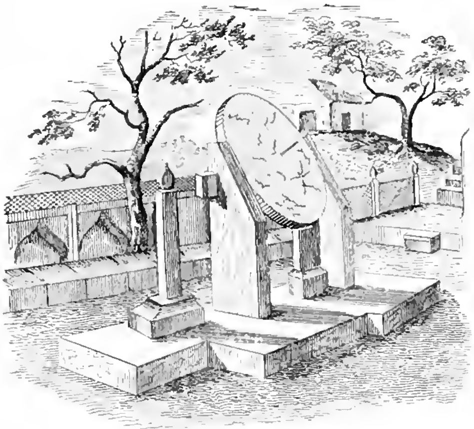
"Between day-break and sun-up" may be a local expression, but it has its analogues in all idioms, and like its congeners, "an hour by the sun," and "the sun two hours high," marks the constant reference by those of out-door occupation to the master of day as the measurer of time. In the latitude of Ohio, a farmer judges of noon in harvest-time by reaching one foot forward to try whether he can step on to the shadow of his head. The tired farm-servant of Mesopotamia "earnestly desired the [eastward] shadow," as he watched the sun gradually decline in the western sky.

It is useless, then, to expect to give a date for the invention of the sun-dial. It was not an *invention*, but an *observation*.

It is evident that the dial having a gnomon which makes with the horizontal plane an angle equal to the latitude of the place is the invention of the Asiatics. It is bootless to inquire whether it originated on the southern slope of the great backbone of the continent, or in far Cathay, by the Yellow Sea. Herodotus, whose fame grows clearer and brighter as years wax and wane, states that the Greeks received the sun-dial from the Chaldeans (see that of Berosus, *infra*). We may fairly judge the character of the ancient dials from those yet remaining in India, which are destitute of modern innovations, such as glass lenses and finely graduated metallic scales.

Dr. Hooker, in his "Notes in Bengal, Nepaul, etc," gives sketches of the sun-dials in the Observatory of Benares. This observatory was built by Jey Sing, Rajah of Jayanagar, upwards of 200 years ago. His skill in mathematical science was so great that the Emperor Mohammed Shah employed him

Fig 1624.

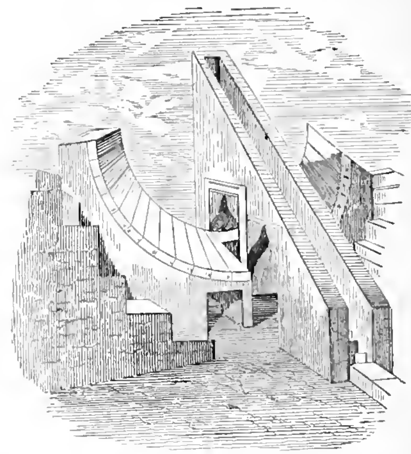


Equatorial Sun-Dial (Benares).

to reform the calendar. He also built the observatories of Delhi, Matra on the Jumna, and Oujein. The *Naree-inla*, or equatorial sun-dial, has a face 26 inches in diameter; the *Semrat-yunta*, or equinoctial sun-dial, has a gnomon 30 feet long, and each quadrant is 9 feet long. These instruments, which are shown in a group in Fig. 309, are particularly interesting, as they carry the eye back to the times of the Chaldean astronomers. There is no reasonable doubt but that these instruments, absolutely devoid of lenses and tubes, are similar to those used by the observers of Mesopotamia and the valley of the Nile, 4,000 years ago. The dial of the Hindoos is described in the Sûrya Siddhânta, or Sanskrit text-book of astronomy, translated for the American Oriental Society, and published in their journal, Vol. VI.

About 771 years before the Christian Era, the Assyrian king Phul invaded Samaria. Thirty-one years afterward, Pekah of Samaria besieged the young King Ahaz in Jerusalem, and the latter sent to Tiglath-Pileser, the Assyrian, then in Damascus, for help against his enemy. This was given. When Ahaz went to Damascus to greet his benefactor, he saw a beautiful altar, and sent working drawings of it to Urijah, the priest in Jerusalem. An altar was completed against his return. In the same spirit of enterprise and taste, and probably from the same trip of observation, he set up the dial which is mentioned in the account of the miraculous cure of his son Hezekiah, thirteen years after Ahaz was gathered to his fathers. This is perhaps the first dial on record, and is 140 years before Thales, and nearly

Fig. 1625.



Equinoctial Dial (Benares)

400 years before Aristotle and Plato, and just a little previous to the lunar eclipses observed at Babylon, as recorded by Ptolemy.

The opinions as to the construction of the dial of Ahaz vary considerably, and the Hebrew word is said, by Colonel White of the Bengal army, to signify a *staircase*, which much strengthens the inference that it was like the equinoctial dial of the Indian nations and of Mesopotamia, from whence its pattern is assumed to have been derived. Cyril, of Alexandria, — the murderer of Hypatia, and not very good authority, — and Jerome, a much better man, agreed in supposing that it had a gnomon and a graduated circle on which the shadow of the gnomon was thrown. The diurnal division of time in the observatories of Chaldea was probably a certain fraction of a solar day; but with most nations the *natural* day was the period between sunrise and sunset, which was divided into twelve periods, which were only the equivalent of our hours at the equinoxes, when days and nights are equal; in summer they were longer and in winter shorter than at the equinoxes. The Chaldeans, Syrians, Hindoos, Persians, Egyptians, Greeks, and Romans thus divided the daylight into twelve periods or hours, while the civil day was the solar day and had twenty-four hours. The dial of Ahaz may have had a vertical gnomon on the upper one of a series of steps, the time being determined by the shadow of the point of the gnomon on the graduations of that arc-shaped step which was designed for that season of the year at which the observation was made. It might thus resemble the analemma, described by Vitruvius, which, by marking the length of the shadows of a fixed gnomon, showed the different altitudes of the sun at the different seasons of the year. Grotius supposed the dial of Ahaz to be a concave hemisphere with a central globe whose shadow fell on the lines engraved on the concavity. This would resemble the Greek *scapha*, a semicircular concave dial, or *hemicyclium*, ascribed by Vitruvius to Berosus the Chaldean, 340 B. C.; this was long in use in Rome, and many have been discovered. It consisted of a semi-spherical horizontal basin with a style erected in such a manner that its extremity was exactly at the center of the sphere. The shadow of the point of the gnomon on the concave surface had the same position with regard to the lower sphere that the sun occupied in the apparent spherical dome of the heavens, eleven converging lines in the concave part dividing it into the twelve hours of the day. So much for the surmises of those whose studies were of Greece and Rome, but to whom the whole Oriental world was not, or was but as a distant and unintelligible murmur. How little even Alexander suspected — he who penetrated the farthest into the teeming and contemplative East — that the most complex and elaborate language of which the world had any knowledge — the Sanskrit — had just ceased to become a spoken tongue! How near the astute Greek came to opening the volume which Providence has given to be the delight and the wonder of the philologists of the nineteenth century! We adhere to the supposition that the dial of Ahaz was a structure like that of Benares.

It will be noticed that the chronicler does not state the result in hours, but in degrees, — a mathematical mode of statement which shows that it had reached its then form through the hands of the astronomers, with whom the division of the circle into 360° was usual at the earliest recorded period at which astronomical instruments are mentioned. The ancient horary division of the Hindoos was into sixty hours. The Chinese divide the solar day into twelve periods, each equal to two of our hours. The Japanese divide the solar day in the same manner, but for common customary purposes the period of daylight into six equal parts. The length of the divisional portions of daylight would therefore vary with the season, but extreme accuracy is dispensed with, and the variations are regulated four times in a year upon the average of three months. The earliest mention of hours is perhaps in Daniel iv. 19, when the prophet became "astonied for one hour." As Daniel was of the great men, we may assume that his coma lasted about sixty of our minutes, as he probably regarded the horary division of the astrologers, rather than the vulgar and fluctuating term of the populace. It is not insignificant that the word *hour* occurs but once in the common translation of the Old Testament, sixty-seven times in the New Testament.

The weekly period is mentioned in the oldest book in the world (Genesis), and dates from the planting of man upon this sphere. The nomenclature of the days, placing them under the regency of the planets, is ascribed to the Chaldeans by some of the ancients, but Dion Cassius (XXXVII. 18) says, with as great probability, that the Egyptians were the first to refer the days to the seven planets. They used the hebdomadal division for certain religious observances, but also the decades or divisions by tens of days, which is also used by the Chinese. Their twelve hours of day and twelve of night were also each dedicated to a genius called *Nau* (hour). Night was held to precede day: "The evening and the morning were the first day" (Gen. i. 5).

The Chinese, ancient Romans, modern European nations, and astronomers generally began or begin the day with midnight; the Chaldeans, Syrians, Hindoos, and Persians with sunrise. With the former he is a great fact, with the latter a god.

"The Egyptians, they said, were the first to discover the solar year, and to portion out its course into twelve parts. They obtained this knowledge from the stars. To my mind they contrive their year much better than the Greeks, for these last intercalate every other year a whole month, but the Egyptians, dividing the year into twelve months of thirty days each, add every year a space of five days [and a quarter] besides, whereby the circuit of the seasons is made to return with uniformity." — HERODOTUS II. 4.

"These [Egyptians] of Thebes seem most accurately to have observed the eclipses of the sun and moon; and from them do so manage their prognostications that they certainly foretell every future event." — DIODORUS SICULUS (60 B. C.).

The Egyptians had the true heliocentric theory of the solar system, which the Greeks could not receive, and which was revived twenty centuries afterwards by Copernicus. It was a great event for Europe when Psammeticus, about 650 B. C., opened the ports of Egypt to the other Mediterranean nations, and encouraged the Ionians and Carians to settle there.

The horoscopus, who occupied the second place in the procession of the Egyptian priests, carried a *horologium*, or sun-dial.

The dial is mentioned in the book of Tobit, which is supposed to have been written by a Jew of Palestine, detailing the experiences of an Israelite of the tribe of Naphthali, who lived in Nineveh in the reigns of Shalmanezer and Sennacherib.

Perhaps the true order of statement would have been better preserved if we had commenced the history of the dial with the Chinese, who are stated, no doubt truthfully, to have used the gnomon from the earliest antiquity; but the notices attainable are so scattering and vague that it is difficult to associate them with the definite details which have been principally referred to so far. The study of astronomy in China is as ancient as the time of Abraham, and the earliest known observations are Chinese (see ASTRONOMICAL INSTRUMENTS), though we have statements of ancient historians that observations quite as ancient were made by the Chaldeans. The dials commonly used in China are mentioned by Mohammedan travelers in that country in the ninth century.

After all this, it seems idle to quote the saying of Pliny, that the sun-dial was originally invented by Anaximander of Miletus (550 B. C.); but that curious writer, to whose appetite for information we owe so much, felt bound to give an origin for everything. He might even have read in Homer (950 B. C.), the not very recondite reference to a sun-dial: —

> "These curious eyes, inscribed with wonder, trace
> The sun's diurnal and his annual race."

The building in Athens long known as the "Tower of the Winds" is now known as the "Horological Monument of Andronicus Cyrrhestes." It had eight faces, each provided with a gnomon and divisional markings.

The dial in the square court of the Alexandrian Museum was visited by an august procession of philosophers during the seven centuries which separated Aristarchus from Hypatia. On the instrument, which had a plane parallel to the equator and a gnomon parallel to the earth's polar axis, Hipparchus, 150 B. C., learned the length of the year, that the four quarters of the year are not of equal length, and also observed the precession of the equinoxes. See ARMILLARY SPHERE.

Before the time of the erection of a sun-dial in the Quirin is by L. Papyrius Cursor, 293 B. C., the time was called by watches, which divided the time between the rising and setting of the sun. About thirty years after, the Consul Marcus Valerius Messala brought to Rome a dial from the spoils of Catania, in Sicily, and this he placed on a pillar near the rostrum; but, not being calculated for the latitude of Rome, it was inexact.

The obelisk erected by Augustus in the Campus Martius was brought by his orders from Egypt. It was originally hewn for Pharaoh Sesothis, according to Pliny, and was 76¾ feet in hight. After being long buried in ruins, it was disinterred but not re-erected by Pope Benedict XIV., and was found to be broken. Pliny states that in its position in the Campus Martius it was "applied to a singular purpose by the late Emperor Augustus, that of marking the shadows projected by the sun, and so measuring the length of the days and nights. With this object a stone pavement was laid, the extreme length of which corresponded exactly with the length of the shadow thrown by the obelisk at the sixth hour (noon) on the day of the winter solstice. After this period the shadow would go on day by day, gradually decreasing, and then again would as gradually increase, corresponding with certain lines of brass that were inserted in the stone; a device well deserving to be known, and due to the ingenuity of Facundus Novus, the mathematician."

On an ancient bas-relief at Rome, an hour-glass is placed in the hands of Morpheus, and Athenæus says that the ancients carried portable hour-glasses with them as measurers of time.

The ancients had three time-measurers, — dials, hour-glasses, clepsydras. Alfred the Great added wax tapers; perhaps Ebu Junis the pulsating lever; Galileo and Huyghens the pendulum. See CLOCK.

The Spaniards found the Mexicans provided with sun-dials for determining the hour, and instruments for the solstices and equinoxes. Their day had sixteen hours, commencing at sunrise. The Peruvians had also their sun-dials. One in Quito, in the form of an obelisk in the center of a circle on which was marked an east and west line, indicated the equinox. These were destroyed by the ignorant Spaniards, who thought them idolatrous. Their ancestors had stared with the same stupid amazement at the Saracenic armils and observatories.

Dials were placed in the gardens of the Tuileries and Luxembourg, so arranged as to fire a cannon at noon. A mortar is placed on the meridian line of the dial, with a burning lens placed over the touch-hole at such a distance and angle that as soon as the sun arrives on the meridian its rays, concentrated by the lens, set fire to the powder, the explosion of which announces the hour of noon.

> "We take no note of time but from its loss;
> To give it then a tongue is wise in man."

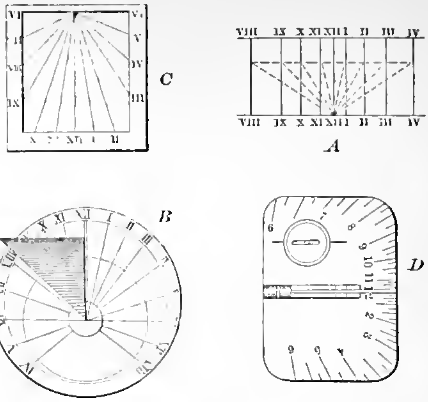
The voice is rather more energetic than anything which melancholy Young had probably anticipated or would enjoy.

Dials are of various construction, according to the presentation of the plane of the dial.

The *polar-dial* (*A*) has a plane parallel to the axis of the earth and perpendicular to the meridian of the place. In this case, the style is parallel to the plane of the dial, and the hour-lines are parallel straight lines, whose distances from the meridional line are respectively proportioned to the tangents of the angles which the hour-planes make with the plane of the meridian.

The *common dial* (*B*) has a horizontal plane, and makes with the style an angle equal to the latitude

Fig. 1626.



Sun-Dials.

of the place, the style preserving its parallelism to the earth's axis. This becomes a *polar dial* at the equator, as the plane of the dial is also parallel to the earth's axis. At other latitudes, the hour-lines intersect each other in the point in which the style intersects the plane of the dial. The angles which the hour-lines make with each other and with the meridional line cutting the XII depend upon the latitude.

The *vertical dial* (*C*) has a plane fixed to a wall, tower, or house. The determination of the hour-lines is similar to the case of the horizontal dial, but the angle formed by the gnomon and dial-plane is the *complement* of the latitude, the style preserving its parallelism with the earth's axis as before.

Varieties of the vertical dial are found with those having presentations east, west, etc. When the plane is east or west, it is in the meridian, is parallel to the vertical plane of the style, and the hour-lines are all parallel.

When a wall dial is not perpendicular, it is said to be *declined*.

When it does not face directly one of the four cardinal points, it is called a *vertical declined dial*.

The dial shows *true* or *solar* time, and not the *mean* time of a well-regulated clock. The dial agrees with such a clock four days in the year.

An *azimuth dial* has a style perpendicular to the plane of the horizon, and marks the sun's azimuth.

The pocket sun-dial (*D*) has a little compass for adjustment, and, of course, is only moderately exact even at its calculated latitude.

2. The graduated and numbered face-plate of a watch or clock. A *dial-plate*.

The old Chinese dials, like the divisions of the clepsydra, were decimally divided. The duodecimal division is later than Kung-fu-tze.

The dial (Fig. 1627) is a suggestion for one

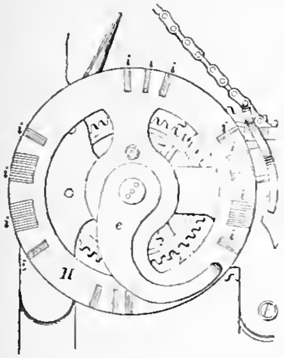
Fig. 1627.

Chinese Clock-Dial.

for the Chinese market; the outer circle has numerals corresponding to Roman numerals. The inner circle has the Chinese horary characters for the periods of two hours each, as they do not indicate these by numbers. The small intervening figures of the inner circle divide the two-hour periods into hours. The index finger or hand makes one revolution in twenty-four hours.

3. (*Telegraphy.*) An insulated stationary wheel having alternating conducting and non-conducting portions against which the point of a spring key is in frictional contact. To the wheel *H* one of the wires of the battery is attached, and the other wire to the axis of the spring-key *e*, whose pointer rests on the wheel. As the key rotates, while it passes over the metallic portion of the wheel, the circuit is complete, and when it passes over the non-conducting portions *i i* of the wheel the circuit is broken. Thus are signals given in Farmer's fire-alarm telegraph.

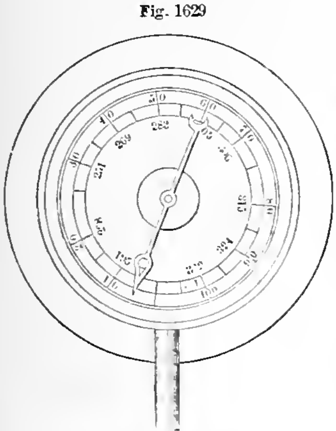
Fig 1628.



Teleg'aph-Dial.

Another form of telegraph-dial is the lettered and number dial of the Cooke and Wheatstone telegraph, in whose center a pointer rotates or oscillates, and directs attention of the observer to the letters, which are spelled *ad seriatim* by this means.

Fig. 1629



Steam-Gage Dial.

4. A circularly graduated plate on which an index-finger marks revolutions, pressure, or what not, in a register, counter, or meter. The cut shows a steam-gage dial which has two graduated circles, one representing pressure, the other temperature.

5. An instrument for holding the *dop* on the end of which the gem is cemented while exposed to the lap or wheel. It has adjustments as to inclination, and also axial, with markers indicating degrees in adjustment, so as to portion out the circumference of the stone in facets forming chords of specific arcs at given depths. See ANGULOMETER.

Di'al-lock. A lock provided with one or more dials, having a series of letters or figures on them. Each dial has a hand or pointer connected by a spindle with a wheel inside the lock; on the wheel is a notch which has to be brought into a certain position before the bolt can be moved. There are false notches to add to the difficulty of finding the true notch in each wheel. To adjust the notches to their proper position, a nut on the back of the wheel is loosened, and the pointer is set at any letter or figure chosen by the user. See PERMUTATION-LOCK.

Di'al-plate. (*Clock.*) The face on which the divisions indicating the hours and minutes are placed.

Di'al-wheel. (*Horology.*) One of those wheels placed between the dial and pillar plate of a watch. Also called *minute-wheel works.*

Di'al-work. (*Horology.*) The motion work between the dial and movement plate of a watch.

Di'a-mond. 1. (*Printing.*) A small kind of type used in English printing: —

Diamond, 205 ems to the foot.
Pearl, 178 ems to the foot.

2. A *lozenge* or *rhomb.* The name is conferred upon nuts and bolt-heads of that form. Also upon gravers which are rhombal, and not square in cross-section.

3. A valuable gem, the hardest of all, and of various colors. It has many uses in the mechanic arts, derived from its extreme hardness; some uses in optics, owing to its high refractive and small dispersive power. Sp. gr. 3.521.

Among the celebrated diamonds may be noted the following: —

Great Mogul. Found in 1550, in Golconda, and seen by Tavernier. Weighed 793 carats; cut to 279 carats (carat, 4 grains).

Russian. Taken from a Brahminical idol by a French soldier; sold to the Empress Catherine for £90,000 and an annuity of £4,000. Weighs 194 carats.

Pitt. Brought from India by Mr. Pitt, the grandfather of the first Earl of Chatham; sold to the Regent Duke of Orleans, in 1717, for £135,000. Weighed when rough, 400 carats; cut to 136½ carats. Napoleon placed it in the hilt of his sword.

Koh-i-noor. Seen by Tavernier in 1665, in the possession of the Great Mogul. Seized by Nadir Shah, in 1739, at the taking of Delhi. Became the property of Runjeet Sing. Captured by the English at the taking of the Punjab. Presented to the Queen by the East India Company, in 1850; weighed in the rough 800 carats, cut to $186\frac{1}{16}$ carats; recut to 103¾ carats. — BRANDE.

Austrian. A rose-cut diamond of 139½ carats.

Sir Isaac Newton suggested that the diamond is combustible, but the first to establish the fact were the Florentine Academicians, in 1694; they succeeded in burning it in the focus of a large lens. Lavoisier, in 1772, examined the results of combustion, which showed it to be pure crystalline form of carbon.

The uses of the diamond include the following: —

Abradant for various purposes, in wheels, laps, and slicers.

Stone drilling and sawing. See CARBON TOOL-POINTS.

Engraver's ruling, and marking graduations on instruments.

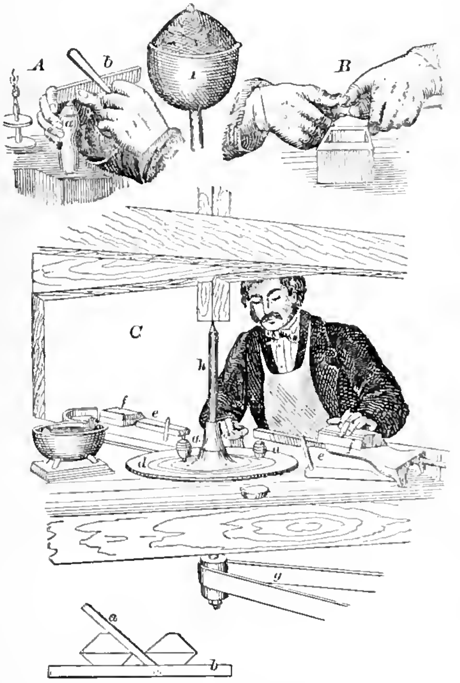
Glass-cutting. Lenses. Jewelry.

Di'a-mond-cut'ter's Com'pass. (*Diamond-cutting.*) An instrument used to measure the inclination of the sides of jewels. It is a movable arm *a*, inserted at an angle of 45° into a metallic base *b*. It is shown in the lower illustration of Fig. 1630 as measuring the inclination of the *collet-side* to the *girdle* and the *bizet* to the *table.* See BRILLIANT.

Di'a-mond-cut'ting. Until 1476, when Louis de Berghem, of Bruges, first discovered this art, the diamond was worn uncut; the four great stones in the mantle of Charlemagne furnishing an example.

The diamond is cut in three forms, the BRILLIANT (which see), the rose, and the table, and their respective values are in the order named. The form a diamond shall assume is determined by its shape in the rough, the duty of the lapidary being to cut it so as to sacrifice as little as possible of the stone and obtain the greatest surface, refraction, and general beauty. Having decided upon the form, a model is made in lead and kept before the workman as a copy. The rough diamond is cemented to a handle called a *dop* (*a*, Fig. 1630), leaving the part exposed which is to be removed to form one facet. The projecting portion is then removed by attrition against another diamond similarly set in a handle (*B*, Fig. 1630), or by means of diamond-dust and oil upon a disk, wheel, or wire, according to circumstances. When a facet is finished, the stone is reset in the

Fig. 1630.



Diamond-Cutting.

handle and the process repeated. Several months are expended in cutting large stones, as the work proceeds very slowly.

The polishing is performed upon a rapidly revolving iron wheel *d*, driven by a band *g*, and fed by hand with diamond-dust and oil (*C*, Fig. 1630). The diamond is set in a dop as before, on the end of a weighted arm *f e*, and held against the wheel; the results of the process being collected in a box for future operations.

The weight of a diamond is expressed in carats equal to four grains; the term is derived from the Arabic *qirat*, a bean, a word derived from the Greek *keration*, signifying *a little horn*, the fruit of the karob-tree.

The value of a diamond is commonly increased threefold by skillful cutting, and its value is the square of its weight expressed in carats multiplied by $ 40 specie. This is but an approximation to the truth, for the value of diamonds fluctuates like other things, though to a less extent.

Diamonds with flaws or imperfections are sawn asunder or split; the latter (shown at *A*) being a speedy but risky operation, requiring great judgment in determining the plane of cleavage and skill in the use of the chisel *b* and hammer. For sawing, a fine wire is used, fed, as in the case of the revolving-wheel, with diamond-dust and oil.

Diamonds are of various colors. They are crystallized carbon, which, not color, determines the chemical difference between the diamond and other gems, such as the ruby, amethyst, topaz, etc., while its hardness expresses its mechanical difference.

Di'a-mond-draft. (*Weaving.*) A method of drawing the warp-threads through the heddles.

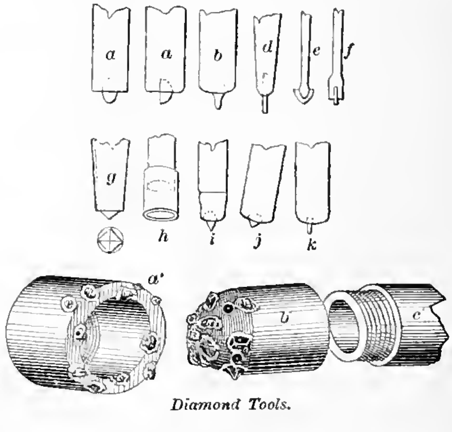
Di'a-mond-drill. A drill armed with a diamond, which cuts its way into the material as the drill-stock is rotated. It was invented by Hermann, and patented in France by him, June 3, 1854. He states that he makes crystals or angular fragments of the black diamond useful in "working, turning, and polishing, etc., of hard stones such as granite, porphyry, marbles, etc." The diamond is broken to obtain angular fragments, which are embedded by alloys in the metallic stock, to form a cutting-tool (*b' c'*, Fig. 1631). See Carbon Tool-points, p. 461.

In his certificate of addition, March 31, 1855, he states that the diamonds are to be inserted in holes drilled for them in the end of the drill-rod, the metal being battered down around them to form a bezel.

The drill-bar slides vertically, and is rotated by bevel-gearing. He refers to the need of water on the drill.

Leschot in 1860-64, and Pihet, in 1866, devoted some care to the matter; the latter introducing

Fig. 1631.



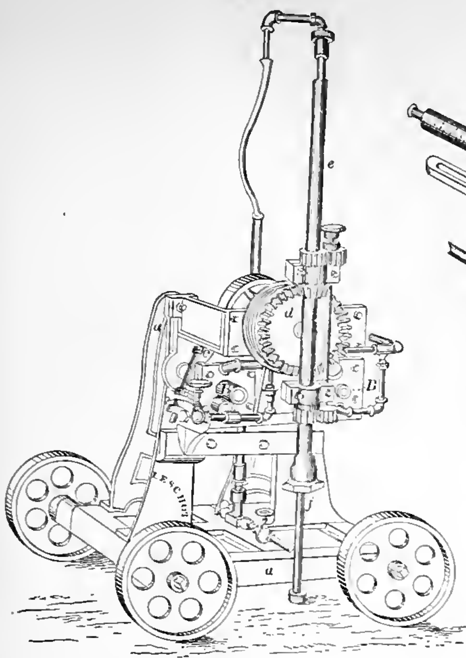
Diamond Tools.

the annular drill-head (shown at *a'*, Fig. 1631), which is a steel ring studded with black diamonds. The heads of the drills used at the Mont Cenis Tunnel, and the excavations by General Newton at Hallet's Point, East River, N. Y., were of this character.

Fig. 1632 represents a prospecting or open-cut drill detached from the boiler which drives it. The two oscillating engines *c* drive the bevel-gearing *d*, which rotates the drill-bar *c f* from 900 to 1,000 revolutions per minute, boring in ordinary rock from 15 to 20 feet per hour. *a* is the frame, *B* the steam connections.

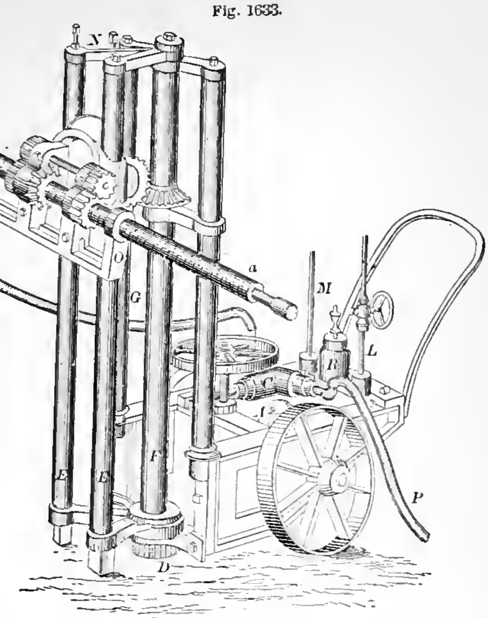
Fig. 1633 is a mining or tunnel drill. The upright frame *E E*, which supports the swivel drill-head with its gears and drill, is attached by hinge-

Fig 1632



Prospecting-Drill.

Fig. 1633.



Tunnel-Drill.

plates to the top and bottom of the driving-shaft *F*, and may be swung to the right or left, describing a semicircle. This allows the drill to act at any angle of the horizontal arc thus described without moving the machine. The drill-head also slides up and down this adjustable frame *E E*, enabling it to bore a perpendicular row of horizontal holes.

The drill itself, with its feed-gears and sliding-guide *O*, may be turned completely round by loosening a nut on the back of the swivel-head so that the point of the drill shall describe a vertical circle, at any angle of which it will bore equally well.

The two uprights *G G* used to support the driving-shaft *F* are made of common hydraulic pipe, and may be lengthened or shortened according to the hight of the tunnel. The driving-shaft *F* has a sliding-gear attached by feather and spline, adjustable at any position. The sliding brace just beneath this gear is used to steady the driving-shaft. Motion is communicated to this shaft by means of the gear *D*. The posts *E E* are set firmly against the upper wall by means of extension-screws *N N*, which may be run up two or three feet if desired. The steam or compressed air is brought through rubber hose from any convenient distance, and introduced into the engine by pipe *L*. *M* is the exhaust-pipe. The feed may be varied at pleasure, and according to the hardness of the rock f.om 90 to 340 revolutions per inch ; that is, from 2 to 10 inches per minute. The machine is balanced on its axle by depressing the handles *H*, and trundled about like a wheelbarrow. Operated by either compressed air or steam.

In Fig. 1631, *a a* are front and side views of diamond-chisels used in turning rubies for watch-jeweling.

b is a diamond-drill for making the hole in the ruby plate.

d is a tool of steel wire to be used with diamond-dust in drilling jewels.

e f are two views of a triangular fragment of diamond mounted for drilling china or porcelain.

g is a square stone mounted for the same purpose.

h is a metallic tube for drilling annular holes in jewels with diamond-dust.

i is a diamond-point mounted for etching or ruling in engraving.

j k are diamonds mounted for ruling graduations of mathematical instruments.

Di′a-mond-gage. Employed by jewelers in estimating the sizes of small diamonds. In the staff are set small crystals of graduated sizes by which jewels are compared. The crystals are from $\frac{1}{4}$ to $\frac{1}{64}$ of a carat.

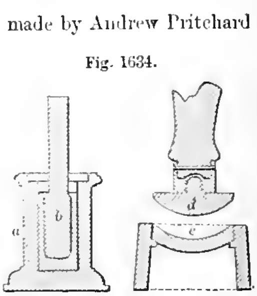
Di′a-mond-head′ed Bolt. See BOLT. A bolt whose head has a *lozenge* or rhombal shape.

Di′a-mond-knot. A kind of knot made at equidistant intervals on a rope, to give support to the hand or foot.

Di′a-mond-lens. The diamond-lens, owing to its high refractive and small dispersive power, requires much less curvature than glass lenses of the same focal length. It therefore admits of the employment of a larger pencil of rays, and gives more light. A diamond and a plate-glass lens of similar form and radius are in their comparative magnifying-powers as 8 is to 3.

Diamond lenses were made by Andrew Pritchard in 1824. One was recently made in London at a cost of £250 sterling.

Fig. 1634.



Diamond Mortar and Grinder.

Di′a-mond-mor′tar. Diamonds for the use of the lapidary are crushed in a mortar, which consists of a cylindrical box *a* and a pestle *b*, both made of hardened steel. A small rough diamond is placed in the mortar, and the pestle driven down by a hammer. The pieces of broken diamond are examined for the detection of fragments suitable for gravers, drills, and etching-points. The remainder is mashed to an impalpable powder by several hours' continued work, rotating the pestle between blows.

When sufficient fineness is not attained by the mortar, the dust may be ground between the concave and convex surfaces *c d* of a hardened steel mill, a little oil being added to the dust. The particles will grind each other.

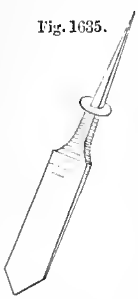
Di'a-mond-nail. A nail having a rhombal head, used for some purposes. The acute angles of the rhomb are sometimes made to clinch.

Di'a-mond-plow. A small plow having a mold-board and share of a diamond shape; that is, rhomboidal. One side of the rhomb runs level on the ground, another forms the breast, and the other two are the marginal lines of the backward extension of the mold-board.

Di'a-mond-point. A stylus armed with a diamond, either ground conical or made of a selected fragment of the desired shape. Wilson Lowry introduced the diamond-point into engraver's ruling-machines. Etching-tools have been pointed with diamonds. Diamond-points are used in ruling the graduation of the finer kinds of instruments, also by Nobert, it is supposed, in ruling the wonderful series of lines that form the tests of the microscopes of higher powers.

Di'a-mond-point Chis'el. A chisel whose corners are ground off obliquely.

Fig. 1635.



Diamond-Point Chisel.

Di'a-mond-tool. (*Metal-working.*) A metal-turning tool whose cutting edge is formed by facets.

Di'a-mond-work. (*Masonry.*) Reticulated work formed by courses of lozenge-shaped stones, very common in ancient masonry.

Di'a-pa'son. (*Music.*) A stop of an organ having pipes or reeds extending throughout the scale of the instrument.

Diapason-stops may be *open* or *stopped*, as the pipes are open above or are closed by *tompions*. *Double-diapason* is an octave graver than *diapason*. See STOP.

Di'a-per. 1. (*Fabric.*) A linen toweling with a small figure thrown up, as in damask.

2. A panel or flat recessed surface covered with carving or other wrought work in low relief.

Di'a-per-work. (*Masonry.*) A pavement checkered by stones or tiles of different colors.

Di'a-phane. (*Fabric.*) A woven silk stuff with transparent and colored figures.

Di'a-pha-nom'e-ter. An instrument for measuring the transparency of the air.

Di'a-phan'o-scope. (*Optics.*) A dark box for exhibiting transparent pictures with or without a lens.

Di'a-phan'o-type. (*Photography.*) Another name for the *hellenotype*, in which a diaphanous or pale positive on a paper rendered translucent by varnish is colored on the back and placed over and in exact correspondence with a duplicate positive of strong character.

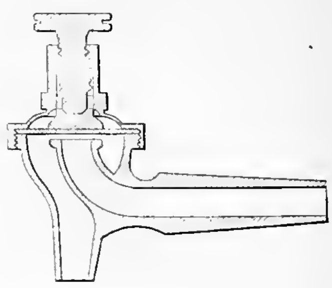
Di'a-phragm. 1. A partition in a chamber, tube, or other object.

Flexible diaphragms are used in steam-pressure indicators, faucets, gas-regulators, pumps, etc.

2. (*Optics.*) An annular disk in a camera or telescope, or other optical instrument, to exclude some of the marginal rays of a beam of light. The original form of this beautiful contrivance is the iris of the eye, which shuts out strong light and regulates the quantity admitted. The use of the iris was known to Leonardo da Vinci.

Di'a-phragm-fau'cet. One which closes its aperture by the depression of the diaphragm upon the end of a pipe by means of a screw-plunger.

Fig. 1636.



Diaphragm-Faucet.

Di'a-phragm-plate. A plate beneath the stage of a compound microscope, to restrict the amount of light reflected from the mirror. The plate has a number of holes of varying sizes, either of which may be brought to bear.

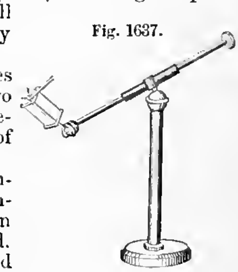
Di'a-phragm-pump. A pump in which a disk-piston is attached by an elastic diaphragm, usually of leather, to the sides of the barrel. It was described by Desaguliers in 1744 as "a piston without friction." It is much older than the time of this philosopher, however. It has been again and again re-invented, and brought out with a flourish of trumpets. See BAG-PUMP. Its application may have been suggested by the human diaphragm.

Di'as-tim'e-ter. A philosophical instrument for measuring distances.

Di'a-style. (*Architecture.*) A system of columniation in which the width of the intercolumns is equal to three diameters of a column.

Di'a-tom-prism. (*Optics.*) A triangular prism used for illuminating small objects in the field by oblique light.

Fig. 1637.



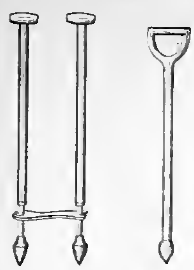
Diatom-Prism.

Di-at'o-ni. Angle-stones in a wall, wrought on two faces, and projecting beyond the general face of the wall.

Dib'ble. A pointed implement with a spade-handle used to make a hole in the ground to receive seed. In the East of England wheat-crops are put in by this means. It is slow, but sure. A man takes a dibble in each hand, and goes backward across the field; children following him drop the grains into the holes. It is economical of seed, but the principal motive is to condense the soil around the seed, so that it may retain moisture in that sandy country which once was a rabbit-warren, and where a certain duchess told the proprietor, Coke of Norfolk, that she saw two rabbits quarreling for one blade of grass.

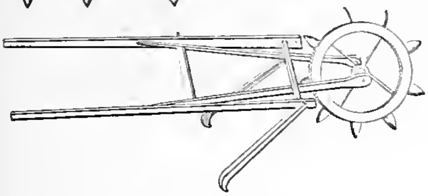
Dib'bling-ma-chine'. One used for making holes in rows for potato sets, for beans, or other things which are planted isolated in rows. It may be adapted for corn by instituting the proper proportion between the parts; corn requiring a greater distance apart in the rows, unless it is only to be tended one way. The machine shown is adapted to be pushed by one man, and may be a useful adjunct to gardening.

Fig. 1638.



About 1649, Gabriel Platte described a *dibbling-machine* formed of iron pins, "made to play up and down like virginal jacks."

Dice. Cubes with marked sides, thrown from a box and used in gaming or determining by chance. The dice of Thebes were cubical, and numbered like the modern, as may be seen by the figure which represents ancient dice in European museums.



Dibblers.

Dice are referred to in several places in the "Rig-Veda," the most ancient of the Sanscrit religious books: —

Fig. 1639.

Ancient Egyptian Dice.

"Let man fear Him who holds the four dice, before He throws them down." — *Rig-Veda*, I. 41, 9 (B. C. 1500).

Rhampsinitus is said by Herodotus to have played with the goddess Ceres, and Mercury is fabled to have played dice with the moon, winning from her the five odd days of the year.

The game of checkers also was played by Rameses, with two sets of men or dogs (*latrunculi*), or counters (*calculi*), of different colors. See CHECKERS.

While the statement of Herodotus possesses a certain historic interest, we cannot credit that dice, knuckle-bones, and ball were invented by the Lydians to while away the alternate days of fasting to which the people were subjected in a time of bitter scarcity. Neither can we credit Socrates when he avers that Palamedes, son of the King of Eubœa, invented dice to serve instead of dinner during the siege of Troy, 1200 B. C.

"Herodotus is mistaken when he says that these sports were invented in the time of Atys, to amuse the people during the famine, for the Heroic times are older than Atys." "In Homer the suitors amused themselves in front of the door with dice [to determine by the chances who should claim Penelope]." — ATHENÆUS, A. D. 220.

Plato is more probably correct in ascribing them to the Egyptians, though the Sanscrit book is as old as the Pentateuch and the Pharaoh who knew Joseph.

The Greek dice were cubes, and were numbered like our own, 6 – 1, 5 – 2, 4 – 3, so that the opposite faces should add 7. They usually threw three dice. The original dice are supposed to have been knuckle-bones, and they still maintained their popularity after the more perfect numbered cube had been introduced. The bones were called *tali*, and were used five in number. The *astragali* were probably cubes without numbers, and played like the knuckle-bones; they were made of bone, stone, metal, ivory, or glass. The number of pieces used was similar to the number of the lines on the Greek *abacus*, or the digits of the hand. (See ABACUS.) The game of *astragali* is represented in ancient sculpture and in a painting in Herculaneum. Pliny mentions a group in bronze by Polycletus of two naked boys at play, then in the Atrium of Titus. The same subject in stone is in the British Museum.

In the game of *duodecim scripta* the moves were determined by dice; the game of *tali* and *tessera* was played with dice. Dice similar to ours were found at Herculaneum, and the convulsion which overwhelmed Pompeii surprised a hazard-party at their amusement; 1800 years afterward the dice were found in their bony hands, and the game yet unsettled.

At an entertainment given in 1357 by the Lord Mayor of London, the Kings of France and Scotland being prisoners and the King of Cyprus on a visit (*temp.* Edward III.), the host challenged all to dice and hazard. — STOW.

The dice-box of the ancients (*fritillus*) was of a cylindrical form, and had parallel indentations to turn the dice as they were shaken.

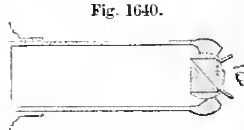
To descend one step lower brings us down to the game of "odd and even" (*par et impar*), a puerile amusement played by the Roman vagabonds with beans, nuts, almonds, or coin. It was played with the fingers in ancient Egypt, in Greece, and in Rome, and still survives in the Mexican *mora*.

Pitch and toss was not so common, but pitching coins or bones within a ring or into a hole was common in ancient Greece.

Thimble-rig was understood and practiced by the ancient Egyptians, much as by the vulgar of the present day. It consisted of four inverted cups hiding an object, such as a pea or other "little joker," and is described by Kenrick and Wilkison.

Di'chro-scope. (*Optics.*) An instrument to exhibit the two complementary colors of polarized light. The quality called the dichroism of crystals consists in transmitting different colors when viewed in different directions. There are several varieties of this apparatus invented by Arago and Brewster.

Fig. 1640.



Dichroscope.

As constructed by Brewster, it consists of a tube about two inches long, blackened on the interior, and attached to a ball and socket.

The ball contains two prisms of calcareous spar, separated by a film of sulphate of lime, so placed that each pair of the four images is tinged with the complementary colors. A lens is arranged upon or near the prisms either at front or back.

On viewing the sky or any luminous object, four brilliantly colored images of the aperture will be seen, the color of the two middle ones being complementary to that of the outer ones. By moving the ball in the socket the colors will constantly change, and the images will sometimes overlap and sometimes separate, exhibiting a great variety of hues, pleasing the eye by their combinations and by the soft harmony of their contrasts.

Many beautiful variations may be obtained by using several films of sulphate of lime having their axes variously inclined to one another.

For other forms of this instrument see "Encyclopedia Edinensis," Vol. XV. pp. 653, 654, and plate cccxlii.

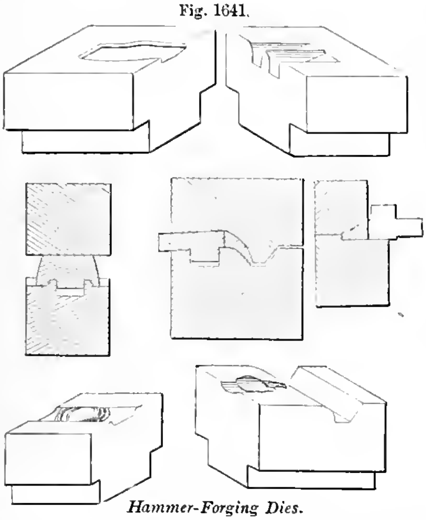
Dic'ing. A mode of ornamenting leather in squares or diamonds by pressure, either of a blunt awl or an edging-tool, or in a machine by pressure between dies.

Dick'ey. A seat behind the body of a carriage for servants. In the old-fashioned English stage-coach it was occupied by the guard and some passengers.

Die. 1. (*Metal-working.*) *a.* In punching-machines, a bed-piece which has an opening the size of the punch, and through which the piece is driven. This piece may be a planchet or blank, or it may be merely a plug driven out of the object to form a bolt or rivet hole. In nut-machines the nuts-blanks may be made by one die and punched by another.

b. (*Forging.*) A device consisting of two parts which coact to give to the piece swaged between them the desired form, as in the example (Fig. 1641), which shows a set of hammer-forging cameo and intaglio dies, which act successively upon the blank.

Fig. 1641.



Hammer-Forging Dies.

c. (*Sheet-metal.*) A former and punch or a cameo and intaglio die between which a piece of sheet-metal is pressed into shape by a blow or simple pressure. See DROP-PRESS.

d. (*Coining.*) Both dies are intaglio, so as to make a cameo or raised impression upon each face of the *planchet*. The upper die has the *obverse*, the *face*, which is often the bust of the sovereign or national emblem. The lower die has the *reverse*, with an effigy, legend, value, escutcheon, as the case may be.

Owing to the random way in which ornaments are disposed on coins, any general definition will no longer meet all cases.

A die for coining, mechanically considered, is made by the following process: A piece of softened steel called a *hub* is prepared, and upon its end the design is cut. The steel is then hardened, and is used to make a *matrix*, in which the impression is *intaglio*, that is, sunken. A plug of softened steel a little larger than its ultimate size, and with the center a little raised, is placed on the bed of a screw-press, and, the hardened matrix being placed upon it, pressure is brought to bear on the matrix, which delivers its impression on the face of the plug. The result is a salient impression, and forms the *punch*. In all cases where metal is condensed it becomes heated and hardened, and in this case it becomes necessary to withdraw the imperfect *punch* and anneal it, after which it receives another pressure from the matrix. This is repeated until the impression is fully developed. The *punch*, by a similar operation, is then employed to make a *die*. The *die* is then hardened, and may be used for coining or for making a new *hub* if the former should become injured. The first perfect die is generally retained for the purpose last mentioned.

Fig. 1642.

Coining-Dies.

The date is put by hand into the *dies* to be used in coining, as it requires to be changed; and the first *die* and the *hub* may be preserved for many years and may make hundreds of *dies*. For the application of the *dies*, see COINING.

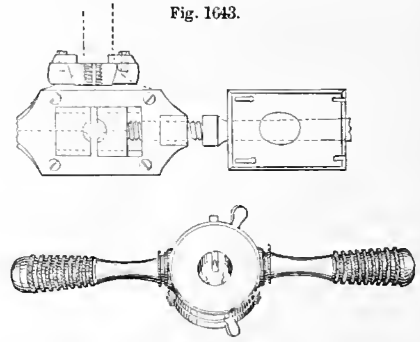
A mode of procedure which saves one step in the above process is to engrave the design in intaglio in the first place. This, when hardened, forms a *matrix*, from which the *punch* is made; the *punch* being used to form the *die* for coining.

A die will sometimes deliver 250,000 impressions before it is necessary to remove it from the coining-press; and sometimes a die will crack at the first impression.

e. (*Engraving.*) An engraved plate or small roller of steel, subsequently hardened and used to deliver an impression upon the surface of a soft steel roller, which in turn is hardened and forms a *mill*. The *die* is *intaglio*, and the *mill* is *cameo*. The latter is used to impress a plate or a roller to be used for bank-note printing or calico-printing respectively. See TRANSFERRING-MACHINE; CLAMMING-MACHINE.

f. One of the pieces which combine to form a hollow screw for cutting threads on bolts and such like. The two portions are fitted in a *stock*. In some, the dies are set up by screws, in others by scrolls.

Fig. 1643.



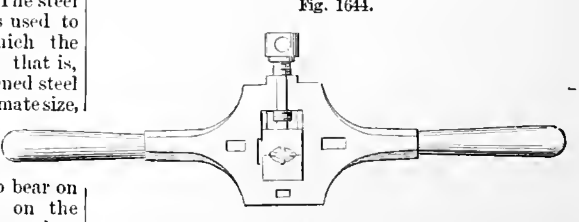
Screw-Cutting Dies.

2. The cube or dado of a pedestal.

3. A cube marked with figures on its respective sides and used in games of chance. See DICE.

Die-sink'ing. The art of making dies for coins, medals, etc. It is a branch of engraving, but in-

Fig. 1644.



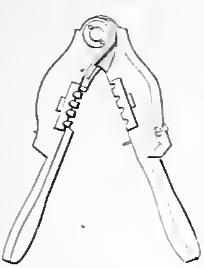
Stock and Dies.

volves turning, tempering, and the use of other tools besides the graver. See DIE.

Di'e-sis. (*Printing.*) The double-dagger (‡), a reference-mark.

Die-stock. A frame to hold the dies for cutting external screw-threads. The dies are detached pieces of steel, containing the thread on their inner curved surfaces, and these fit into grooves or upon ridges in the slot of the die-stock, being closed upon the bolt to be threaded by means of a set screw.

Fig. 1645.



Die-Stock.

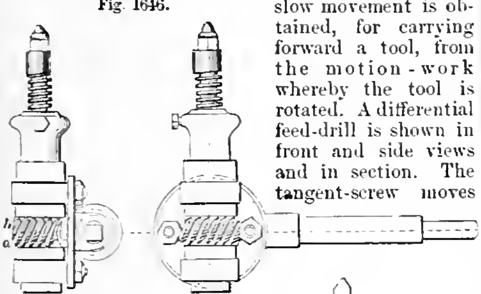
Plier die-stocks are made by setting removable dies in the jaws of pliers.

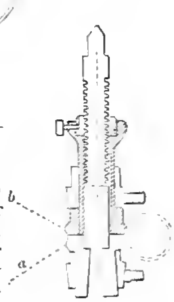
Diffe-ren'tial Block. A double block having sheaves of different sizes. See DIFFERENTIAL PULLEY.

Diffe-ren'tial Coup'ling. A form of extensible coupling, to vary the speed of the driven part of the machinery.

Diffe-ren'tial Feed. An arrangement by which a regular powerful and slow movement is obtained, for carrying forward a tool, from the motion-work whereby the tool is rotated. A differential feed-drill is shown in front and side views and in section. The tangent-screw moves at the same time the two worm-wheels *a b*; the lower one has fifteen teeth and rotates the tool, the upper has sixteen teeth, and by the difference between the two, the odd tooth advances the tool gradually by the rotation of the axial screw.

Fig. 1646.





Differential-Feed Drill.

Diffe-ren'tial Gear'ing. A form of gearing first introduced by Dr. Wollaston in his *trochiometer*, for counting the turns of a carriage-wheel, in which two cog-wheels of varying sizes are made to travel at the same absolute surface-rate and in the same direction, and communicate motion equivalent to the difference between the circumferences of the two. See, for an illustration, DIFFERENTIAL FEED. See also EQUATIONAL-BOX.

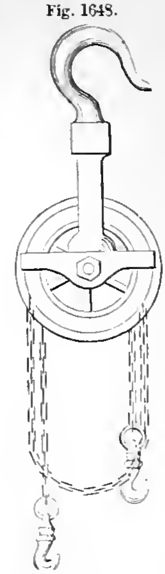
Diffe-ren'tial Pul'ley. This, in a somewhat clumsy form, has been known for centuries under the name of the Chinese windlass, and one was found by the allied English and French armies to be in use for raising one of the drawbridges in the city of Pekin. It was described by Dr. Carpenter in his "Mechanical Philosophy," etc., 1844.

The chain winds over two drums of different diameters, winding on to one as it unwinds from the other; the effect gained is as the difference between the two, the smaller the difference the greater the power and the less the speed.

Fig. 1647.

Differential Pulley.

Fig. 1648.



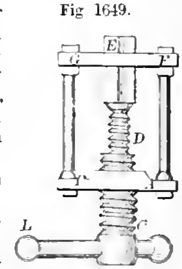
Differential Pulley.

In the geared differential pulley the effect is produced by making one more tooth in one of the wheels the chain passes over than in the other.

Diffe-ren'tial Screw. Invented by Hunter, the celebrated surgeon. Two threads of unequal pitch are upon the same shaft, one unwinding as the other winds. The effective progression is equal to the difference of the pitches of the two threads. By making this difference very small, great power may be attained without the weakness due to a very fine screw.

A B is a plate of metal in which the screw *C D* plays. This screw is hollow, and receives the smaller screw *D E*, which is free to move longitudinally, but is restrained from rotating by the frame *A F G B* of the press. The larger screw has ten threads to the inch, the smaller one has eleven.

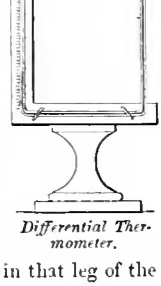
Fig. 1649.



Differential Screw.

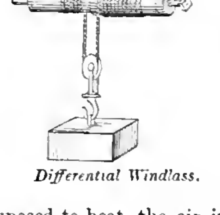
Diffe-ren'tial Ther-mom'e-ter. A thermometer having two air-bulbs connected by a bent stem occupied by colored sulphuric acid. When one leg is exposed to heat, the air in the bulb is expanded, and the liquid in that leg of the instrument is depressed.

Fig. 1650.



Differential Thermometer.

Fig. 1651.

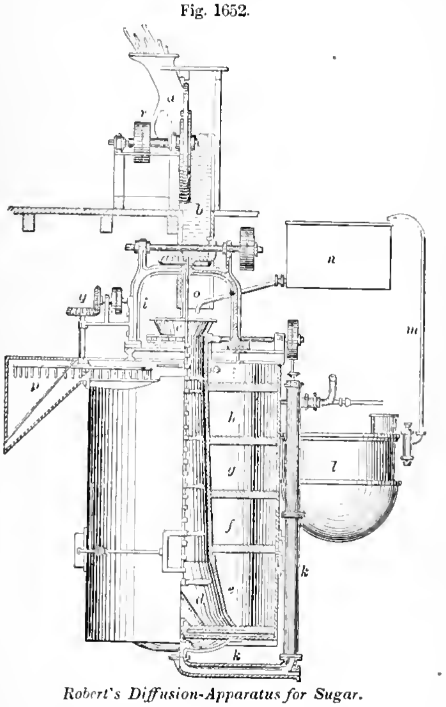


Differential Windlass.

Dif-fe-ren'tial Wind'lass. A windlass whose barrel consists of two portions of varying diameters. The rope winds on to one as it winds off the other, the effect of a revolution being governed by the difference between the circumferences of the two portions. If it wind on to the larger and off of the smaller the load is raised, and conversely. See CHINESE WINDLASS.

Dif-fu'sion-ap-pa-ra'tus. (*Sugar-manufacture.*) A mode of extracting the sugar from cane or beet-root by dissolving it out with water. It is adopted in some establishments in British India and in Austria. The sugar-yielding material is fed in at the hopper *a* and cut into slices in the cylinder *b* by knives driven by band-wheel *r*, and issues at the opening *o* into the hopper *c*, where it is carried down the central pipe *d* and discharged into the lower

Fig. 1652.



Robert's Diffusion-Apparatus for Sugar.

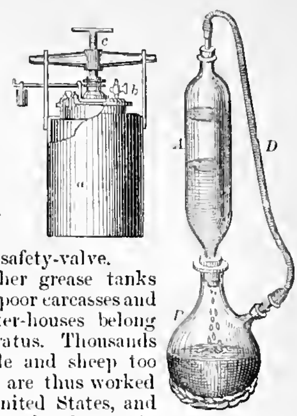
chamber *e*, and, gradually ascending through the series of chambers *f g h i*, is carried off by a rake *p* driven by gearing *q*. As the slices of cane rise in the diffusing-chambers, they meet water, which is supplied from above through small pipes, the water meeting first the most exhausted slices as they rise to the discharge-level, and passing through to the richer material as it becomes more and more saturated. At the bottom it issues through perforations or outlet-pipes *k*, and is carried off to a cistern *l*, where it is heated, and is then returned upon the cane through the pipe *m* and the cistern *n* and the central feeding-tube, by which the cane or beet is supplied to the diffusing-chamber.

Dif'fu'sion-tube. An instrument for determining the rate of diffusion of different gases. It consists of a graduated tube closed at one end by plaster-of-paris, — a substance which, when moderately dry, possesses the required porosity. — THOMAS.

Di'gest-er. Invented by Dr. Papin, about 1690.

A strong boiler *a* with a tightly fitting cover *b*, closed by a screw *c*, and used to expose food to a heat above 212°. By a certain increment of heat the gelatine is separated from the phosphate of lime of the bones; the earthy particles sinking to the bottom. It has a safety-valve on top to allow steam to escape when it begins to acquire a dangerous tension. It was in contriving this boiler that Dr. Papin invented the safety-valve.

Fig. 1653.



Digesters.

The lard and other grease tanks used for working up poor carcasses and the offal of slaughter-houses belong to this class of apparatus. Thousands of carcasses of cattle and sheep too poor for the market are thus worked up yearly in the United States, and the lard-tank is a regular feature in the hog-slaughtering centers, Chicago, Cincinnati, etc., where the entrails and other offal yielding grease are thus treated on a large scale.

The tanks have also been introduced into Buenos Ayres and probably into Texas, where beeves are slaughtered for their hides and tallow. The carcasses, after removing a few choice parts, are dumped into the tanks, when steam is applied, resolving them into fat, water holding soluble matters in solution, and mud, the latter containing the earthy and some other particles.

Of this class is Wilson's tank for rendering lard and tallow, patented in 1844. The tank is preferably a vertical cylinder, and is calculated for high-pressure steam. It has a perforated steam-pipe below the perforated false bottom which sustains the charge, and allows the water of condensation to percolate into the lower chamber. A discharge-hole at bottom is provided for removing the residuum. A number of try-cocks at different hights afford means for determining the levels of the fat and water respectively; and discharge-cocks permit the floating fat to be decanted or the water withdrawn, as the contents and state of the process may require.

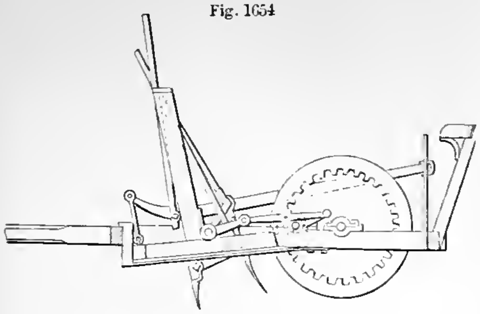
The figure on the right hand shows an apparatus in which tannin is extracted from the vegetable substances which yield it,—say, for instance, nut-galls. It is an elongated glass vessel *A*, having an orifice at top which is fitted with a ground-glass stopper, and contracting at its lower extremity so as to fit into the neck of a bottle or matrass *B*, which receives the extract. The matrass connects by proper orifices and a caoutchouc-tube *D* with the vessel *A*, so that the ether which lies upon the nut-galls in the upper vessel and forms the menstruum of the extract in the lower one shall not evaporate.

Dig'ger. A name applied to some forms of spade-like implements in which the soil is lifted and turned by other than the usual modes. More curious than useful.

Dig'ging-ma-chine'. (*Agriculture.*) A spading-machine for loosening and turning the soil. There are many forms, which may be classed under two heads, reciprocating and rotary.

Fig. 1654 represents one kind in which the spade-handles pass through guide-slots in an upper bar, and receive their motion by attachment to cranks revolved by connection with the drum. The depth

Fig. 1654

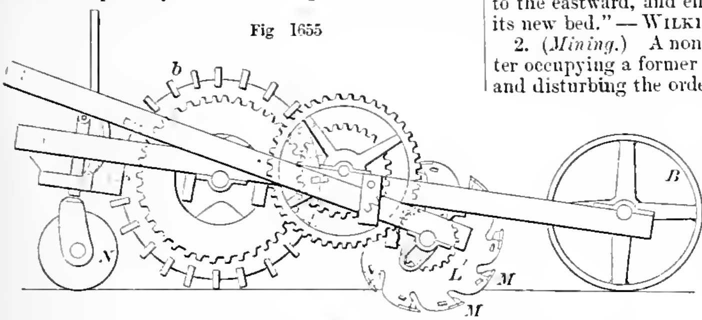


Reciprocating Spading-Machine.

is regulated by the vertical adjustment of the tilting-frame which carries the crank-shaft.

In the rotary machine (Fig. 1655) the ground-wheel *b* drives the spade-wheel *L* through the intervention of gearing. The wheel *B* is in the advance, and the depth of penetration is regulated at the rear

Fig 1655



Rotary Digging-Machine.

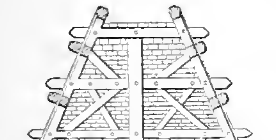
of the frame above the caster-wheel *N*. The shares *M M* are removable.

Other forms of spaders have blades thrust out and retracted as the machine advances.

Digue. A sea-wall or breakwater. An artificial construction opposing a barrier to the sea or preventing the denudation of the land thereby. See DIKE.

Dike. 1. A levee or wall of earth, gabions or carpentry, to prevent the encroachment of water, or to serve as a wharf or jetty.

Fig. 1656.



Rouen Quay.

The structures vary extremely, according to purpose, exposure, and the nature of the foundations. The more superior class consists of a timber structure strongly braced, founded on piles, filled in with stone, and faced with planking or masonry. See SEA-WALL; JETTY; BREAKWATER.

The dikes of Holland are the most memorable of their class, and protect from the sea that wonderful land which is so largely below the high-water sea-level. The dikes in some parts of Holland are thirty feet above the ordinary level of the country, and have sufficient width at top to form a roadway. They are founded on timbers and piles filled in with stones faced with clay and revetted with gabions of rushes, willows, etc. The slope to the sea is from 1 rise to 4 base down to 1 in 13.

The history of these works is one of gradually increasing strength and solidity, with heroism and pertinacity wonderful to relate. The accidents by which the sea has again and again claimed its own have swept away whole provinces and communities. A flood in 1277 formed the present Gulf of Dort and overwhelmed forty-four villages. The flood of 1287 overwhelmed 80,000 persons, and gave the Zuyder Zee its present bounds. Another storm in the sixteenth century destroyed 100,000 persons.

The Haarlem Lake is the latest of the great reclamations. The cost of rendering habitable and cultivable the 51,300 acres was $3,330,000, about $65 per acre. Previously to undertaking this colossal work, the Zind Plass, of nearly 11,500 acres, had been reclaimed at a cost of $1,250,000, not far from $110 per acre.

Among the most celebrated of dikes was that of Menes, which turned the Nile from its course to accommodate the new city of Memphis. "Its lofty mounds and strong embankments turned the water to the eastward, and effectually confined the river to its new bed." — WILKINSON.

2. (*Mining.*) A non-metallic wall of mineral matter occupying a former fissure in rock, intercepting and disturbing the order of ore-bearing strata.

3. A stone fence (Scotland).

4. A ditch for water.

Di-lat'or. An instrument for extending parts, such as the eyelids, or dilating the walls of a cavity, the urethra, vagina, anus, etc. See the following: —

Anal dilator.
Eyelid-dilator.
Lachrymal-duct dilator.
Speculum.
Sphincter-muscle dilator.
Stricture-dilator.
Urethra-dilator.
Uterine dilator.

Dil'i-gence. A French stage-coach. It was the national vehicle on the regular routes; had four wheeels, two compartments, a deck, and a dickey; was drawn by from four to seven horses, and engineered by a postilion.

Dil-lu'ing. A Cornish word for the operation of sorting ores in a hand-sieve. The sieve has a hair bottom of close texture, and contains about thirty pounds of stamped tin ore. The sieve is immersed in water and moves the ore up and down and circularly, so as to cause all the particles to be in a state of suspension in the water.

By inclining the sieve the lighter particles are allowed to run off into the *keeve*, while the richer particles are laid aside for *roasting*.

Di-lut'ing Rol'ler. A roller in paper-making machinery, which conducts an additional supply of water into the pulp-cistern to reduce its density.

Dim'i-ty. (*Fabric.*) A heavy, fine, white cotton goods, with a crimped or ridged surface; plain, striped, or cross-barred.

The Greek *dimitos* (double warp-thread) is believed to have been a kind of twilled fabric, and was equivalent to the Latin *bilix*.

Di'men-sion Lum'ber. Lumber sawed to specific sizes to order, in contradistinction to *stock-lumber* which has the usual market-sizes. See STOCK-GANG.

Di'men-sion Stone. Ashlar (which see).

Di-min'ish-ing-staff. (*Shipbuilding.*) Planking wrought under the wales, and thinned to correspond with the thickness of the bottom plank.

Ding-dong. (*Horology.*) A striking arrangement in which two bells of different tones are used and struck in succession to mark the quarter-hours.

Diuged-work. Work embossed by blows which depress one surface and raise the other. See CHASING.

Din'gy. 1. A row-boat of the Hoogly, which probably gave the name to the little jolly-boat of the merchant-service, mentioned below.

2. A boat of Bombay, propelled by paddles, and having one mast and a settee-sail.

3. An extra boat of a ship for common uses. It is clinker-built, from 12 to 14 feet long, and has a beam one third of its length.

Di-op'ter. An ancient altitude, angle, and leveling instrument; said to have been invented by Hipparchus. *Dioptra.*

Di-op'tric Light. The dioptric system of lighting, used in lighthouses, as distinguished from the catoptric, which is by reflectors. Refraction instead of reflection.

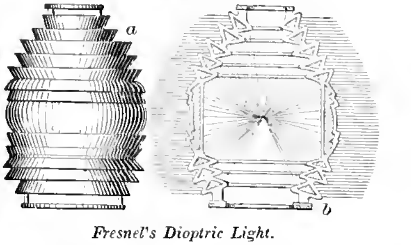
Lenses were used in the South Foreland light in 1752, and in the Portland light, England, in 1789. The system fell into disfavor, owing to certain mechanical difficulties in the construction and arrangement of the lenses.

It was revived and improved by Fresnel about 1810, and has been generally adopted throughout France and Holland, and partially in England. It is considered superior to the catoptric, and was re-adopted in England in 1834, being placed in the Lundy Island Lighthouse, Devonshire, England.

The Fresnel dioptric lamp consists of a mechanical, four-wicked oil-lamp, placed in the center of an octagonal glass prism; the center part of each of the sides being formed of a plano-convex lens of about 15 inches diameter, which is surrounded by a series of glass rings of a spherical triangular form, so as to produce the same effect upon the rays as is produced by the central lens. Allan Stevenson, Arago, and Faraday are credited with improvements in the details.

The flame is placed in the focus of the lenses, and the beams are bent parallel to each other, so as to form a solid beam of light proceeding from each

Fig 1657.



Fresnel's Dioptric Light.

lens. The lenses, after careful and persistent attempts, were merged into a cylindrical hoop which formed the central zone around the flame, as seen in the elevation *a*. The rays striking above and below were bent so as to assume a position parallel to those proceeding from the hoop, as seen in the section *b*.

Di-op'tric Mi-crom'e-ter. A form of the double image micrometer, introduced by Ramsden (1735–1800), in which the divided lens is in the eye-tube. In the ordinary form it is the object-glass which is divided.

Di'o-ra'ma. A mode of scenic representation in which the spectator and picture are placed in separate rooms, and the picture viewed through an aperture the sides of which are continued towards the picture, so as to prevent the distraction of the eye by other objects. All light admitted passes through this aperture from the picture, which is illumined by light from above at such an angle as to be reflected through the aperture towards the spectators. By means of shutters, screens, and reflectors, the light is modified to represent changes of sunlight, cloud, and moonlight. Transparent portions of the picture admitting light from behind brilliantly illuminated certain portions.

M. Daguerre was one of the artists of the dioramic exhibition at Regent's Park, London, in 1823. He is justly famous in connection with his heliographic discoveries. He died in Paris, January 10, 1851, aged 62. M. Bouton was associated with Daguerre in the invention and exhibition.

Dip. 1. (*Compass.*) The vertical angle which a freely suspended needle makes with the horizon. *Inclination.* See DIPPING-NEEDLE.

2. (*Mining Engineering.*) The inclination or pitch of a stratum. The point of the compass towards which it declines is the *point of dip*. The angle with the horizontal is the *amount of dip* or the *angle of dip*. The *strike* is the extension of the stratum at right angles to the *dip*. *Dip* is also known as *hade, slope, underlie.*

3. The depth of submergence of the float of a paddle-wheel.

4. A candle made by repeated dipping of the wick in melted tallow.

5. The slight downward inclination of the arms of an axle. *Swing.*

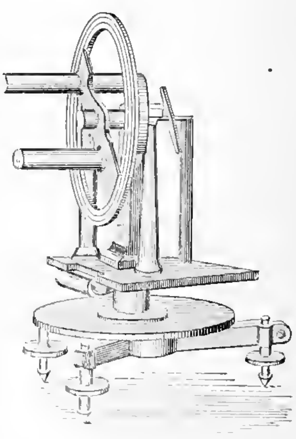
6. (*Fortification.*) *a.* The superior slope of a parapet.

b. The inclination of the sole of an embrasure.

Dip-cir'cle. A vertical graduated circle, in the plane of which a delicate magnetic needle is suspended on a horizontal axis, which rests upon two polished agate supports. The circle is set in the plane of the magnetic meridian, and the needle indicates upon the graduated circle the angle of inclination.

In the improved form shown at Fig. 1658, the needle is insulated from other metal, and the readings are effected by two telescopes fixed on opposite ends of an arm traversing a graduated circle.

Fig. 1658.



Dip-Circle.

Dip-head Lev'el. (*Mining.*) The gallery proceeding right and left from the engine-pit bottom. The *main*-level.

Di-plei'do-scope. An optical instrument for indicating the passage of a heavenly body over the meridian by the coincidence of two images formed by a single and double refraction from a triangular prism which has one transparent and two silvered planes, one of the latter being in the plane of the meridian. — BRANDE.

Dip'per. (*Photography.*) An instrument used for immersing negative plates in upright baths containing nitrate of silver, hyposulphite of soda, cyanide of potassium, etc., and withdrawing the same after sensitizing or fixing. They are slender flat strips of hard rubber, wood, glass, porcelain, and sometimes silver wire, having short projections upon which to rest the edge of the plate, which stands nearly upright in the bath while the chemical changes take place.

Dip'ping. 1. The process of brightening ornamental brass-work.

a. The grease is removed by heat or lye.
b. The work is *pickled* in dilute aquafortis.
c. Scoured with sand and water.
d. Washed.
e. *Dipped* in a bath of pure nitrous acid for an instant.
f. Washed. *g.* Rubbed with beech sawdust.
h. Burnished. *i.* Lacquered.

2. Plunging sheet-iron plates in the pickle or the tin-bath in tinning.
3. Wicks in the tallow-vat.
4. The wool or fabric in the dye-tub.
5. The paper form in the pulp.

And so on of various operations in the arts, mechanic and fine.

6. The Scotch term for the *dubbing* of American and English curriers. It consists of boiled-oil, fish-oil, and tallow.

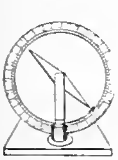
7. (*Photography.*) Immersing the collodionized plate in a sensitizing bath.

Dip'ping-frame. 1. A frame from which candle-wicks are suspended while dipping into the vat of melted tallow. See CANDLE.

2. (*Dyeing.*) A frame on which the fabric is stretched and immersed in dyeing with indigo.

Dip'ping-nee'dle. The inclination or dip of the magnetized needle was not known to the Chinese, who had discovered its variation during the twelfth century.

Fig. 1659.



Dipping-Needle.

This element of terrestrial magnetism appears to have been discovered by Robert Norman, a compass-maker of Ratcliff, London, who detected the *dip* and published the fact in 1576. He contrived the dipping-needle, and found the dip at London to be 71° 50'. See also DIP-CIRCLE.

Captain Sir James Ross, the celebrated Arctic navigator, reached the magnetic pole, latitude 70° 5' 17" north, and longitude 96° 46' 45" west, on the 1st of June, 1831. The amount of dip was 89° 59'. Horizontal needles refused to work, showing no sensitiveness. He erected a cairn of limestone rocks, inclosing a tin case containing the record. The cairn may remain, unless the Esquimaux Indians have removed it in search of plunder, but the magnetic pole has moved away.

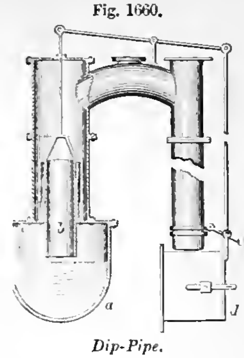
The dipping-needle is one of the instruments furnished to the chain of observatories which are dotted over the earth. See MAGNETOMETER.

Dip'ping-pan. (*Stereotyping.*) A square, cast-iron tray in which the *floating-plate* and plaster-cast are placed for obtaining a stereotype cast. The floating-plate is to form the back of the stereotype, and the mold the face; the dipping-pan forms the flask, and is plunged beneath the surface of the metal in an iron pot. The metal runs in at holes through the lid and forces apart the plate and mold.

Dip'ping-tube. A tube for taking microscopic objects out of a liquid. See FISHING-TUBE.

Dip-pipe. A device, also known as a *seal*, in the hydraulic main of gas-works. In the illustration, the seal-cup *a* is charged with tar, which per-

Fig. 1660.



Dip-Pipe.

mits the movable dip-pipe *b* to be lifted into or out of the main. The lid *c* cannot be removed from the mouthpiece until the handle is raised, which removes the lock and seals the dip. When the retort is again charged, and the lid fastened by bearing down the handle of the lift, the lid is locked and the dip is again raised.

Dip-roll'er. (*Printing.*) A roller to **dip** ink from the fountain.

Dip-sec'tor. A reflecting-instrument. One was invented by Dr. Wollaston, and one by Troughton. It is used for ascertaining the true dip of the horizon; the principle is similar to the sextant.

Dip'ter-on. (*Architecture.*) A temple having a double row of columns on each of its four sides. Such an edifice is said to be *dipteral.*

Di-rect'ing-cir'cle. A ring used in giving the proper shape in making gabions.

Di'rect-ac'tion Steam-en'gine. A form of *steam-engine* in which the piston-rod or cross-head is connected directly by a rod with the crank, dispensing with working-beams and side-levers. They may be classed generally under three heads: those which obtain the parallelism of the piston-rod by means of the system of jointed rods called a *parallel motion*; those which use *guides* or sliding surfaces for this purpose; and those denominated *oscillating*-engines, in which the cylinder is hung upon pivots and follows the oscillations of the crank. More specifically as follows: —

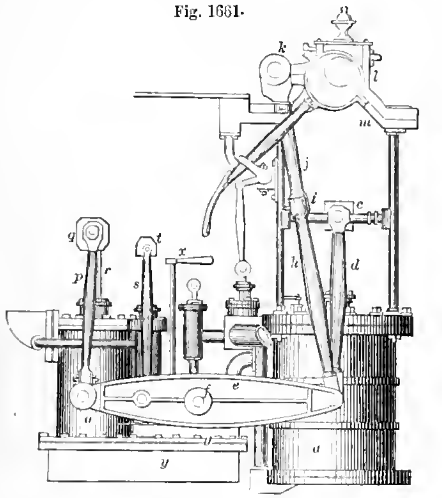
Annular cylinder steam-engine (*Maudslay's*).
Double-cylinder steam-engine (*Maudslay's*).
Double-piston steam-engine (*Maudslay's*).
Gorgon steam-engine (*Seaward's*).
Inclined cylinder steam-engine (*Brunel's*).
Inverted cylinder steam-engine (*Galloway's*).
Inverted double-cylinder steam-engine (*Hick's*).
Oscillating cylinder steam-engine (*Witty's*).
Sliding-cover steam-engine (*Parkyn's*).
Steeple steam-engine (*Trevethick, Napier*).
Trunk steam-engine (*Humphery's*).
See under the respective heads.

In Napier's direct-action steam-engine, the beam is retained, but only for the purpose of working the pumps.

The cylinders are arranged alongside of each other, and work the cranks on the main shaft, the cranks being set at 90° with each other; but one of the cylinders shows in the side elevation. The cylinders *a* are fixed to a framing, which is bolted to the bottom of the boat. The piston-rods are keyed at the upper ends to cross-heads *c*, to the exterior ends of which are attached the connecting-rods *d*. The lower ends of the latter are inserted in the fork ends of the beams *e*, which vibrate upon a shaft *f*, the bearings of which rest on the top of the condenser *g*. In the same forks are inserted the ends of other connecting-rods *h*, which are keyed at their upper ends to cross-heads *i i*. In the center of these cross-heads are bosses large enough to receive the rods *j j*, which extend to the crank-pins of the cranks *k k*. These cranks are fixed to the main shaft, which rests upon the bearings *l l*, upon the arches *m*, which are bolted to the cross-beam.

The side-beams *e e* are not straight, but have two bends, the ends near the cylinder being much farther apart than the opposite ends, which are alongside the air-pump, so that they conform somewhat to the shape of the machine, and take up as little room as possible. The beams *c c* are also forked at their ends nearest to the air-pump *o*, in order to admit the insertion of the pump-rods *p*, which are connected at their upper ends with the cross-head *q*, in a bush in the center of which is keyed the air-pump rod *r*. Connecting-rods *s* are

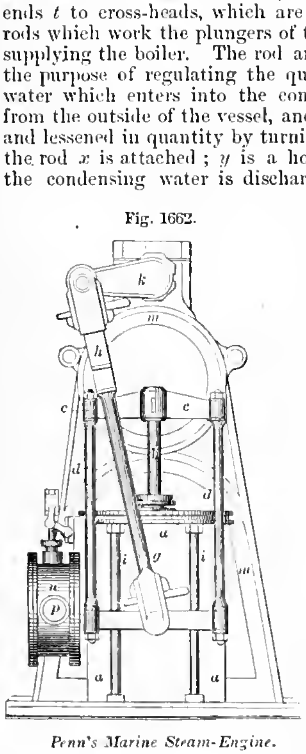
Fig. 1661.



Napier's Direct-Action Steam-Engine.

attached to the side beams *c*, and at their upper ends *t* to cross-heads, which are connected to two rods which work the plungers of two feed-pumps for supplying the boiler. The rod and lever *x* are for the purpose of regulating the quantity of injection water which enters into the condenser, by a pipe from the outside of the vessel, and can be increased and lessened in quantity by turning a cock to which the rod *x* is attached; *y* is a hot-well, into which the condensing water is discharged from the air-pump. The feed-pumps are supplied with water from this hot-well, through the medium of a pipe, the overplus being discharged through the side of the vessel by another pipe (not shown).

Fig. 1662.



Penn's Marine Steam-Engine.

In Penn's direct-action steam-engine, *a* is the cylinder; *b* the piston-rod, carrying the cross-head *c c*; this latter consists of four arms, branching diagonally from the center. On each side two side-rods *d d* are suspended from the extremities of the arms *c c* of the cross-head, and are attached at the lower end to a cross-bar, in the center of which is a pin, to which the forked end of the arm *g* of the connecting-rod *h* is coupled; *i i* are two guide-rods, upon which the bar *e* slides, the rods passing through brass bushes attached to the side of the bar; *k* is the crank, and *m* the side frame; *n* the slide-case, and *p* the steam pipe.

Di'rect-draft. In steam-boilers, when the hot air and smoke pass off in a single *direct* flue. In contradistinction to a *reverting*, a *wheel*, or a *split* draft.

Di-rect'or. 1. (*Electricity.*) A metallic instrument on a glass handle, and connected by a chain with the pole of a battery or Leyden jar. It is applied on that part of a body to which a shock is to be sent.

2. (*Surgical.*) A grooved instrument for guiding a bistoury, bullet-extractor, etc.

Dirk. A dagger. The name is Celtic (*diurc*), and the weapon forms part of the equipment of a Scotch highlander and an English midshipman.

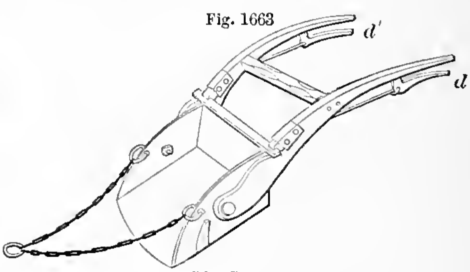
The scalping-knife, stiletto, and bowie-knife are similar implements in favor with other people.

Dirk-knife. A knife with a hinged dirk-blade.

Dirt-board. (*Carriage.*) A board for warding off earth from the axle-arm. A *cuttoo-plate.*

Dirt-scrap'er. A grading-shovel. A road-scraper. An implement drawn by a pair of horses, managed by one man, and used in leveling, banking up,

Fig. 1663



Dirt-Scraper.

or grading ground. In the example, the shovel turns upon pivots in the frame, and its rear end is engaged by spring catches, which are retracted by levers beneath the handles. Pressure on the triggers *d* allows the shovel to capsize and dump its load.

Dis-charge'. 1. The issuing direction of water from a reaction or turbine wheel: as, the *outward* discharge, or Fourneyron turbine; the *vertical* discharge, or Jonval turbine; the *center* discharge, etc.

2. An ajutage.

Dis-charg'er. 1. (*Calico-printing.*) A material with which cloth is printed, in order that the color in which the cloth is subsequently dipped may be removed from those portions printed with the discharger.

The *discharger* acts either upon the coloring matter, or on the mordant before the cloth is exposed to the dye. It acts chemically by converting the coloring-matter into colorless or soluble products; or upon the mordant by removing its effectiveness in setting the color.

It differs from a *resist* in this, —

A *resist* is an application to prevent a color taking upon a cloth. A *discharger* is to remove it.

2. (*Electricity.*) See DISCHARGING-ROD.

Dis-charge'-style. (*Calico-printing.*) *a.* A mode of calico-printing in which thickened acidulous matter, either pure or mixed with mordants, is imprinted in certain points upon the cloth, which is afterwards padded with a dark-colored mordant, and then dyed, with the effect of showing bright figures on a darkish ground. Also known as the *rongeant-style.*

b. A mode in which certain portions of color are removed from dyed goods by the topical application of chlorine or chromic acid. See DECOLORING-STYLE; BANDANNA.

Dis-charge'-valve. In marine engines, a valve covering the top of the air-pump, opening when pressed from beneath.

Dis-charg'ing-arch. (*Architecture.*) One built above a lintel to take the superincumbent pressure therefrom.

Dis-charg'ing-rod. A instrument to discharge a charged electrical jar or battery. It has a glass handle and a pair of hinged rods with balls on the ends, which are brought into connection respectively with the two surfaces or poles of the jar or battery.

Dis'en-gag'ing-gear. (*Machinery.*) Contrivances by which machines are thrown out of connection with their motor, by disconnecting the wheels, chains, or bands which drive them. See CLUTCH; COUPLING.

Dish. 1. (*Vehicle.*) The projection outwardly of the tire beyond the plane of the insertion of the spokes in the hub.

This is not necessary when the spindle of the axle is cylindrical, but when the spindle is tapering, it is necessary to give a *gather* and *swing* to the spindle, and a *dish* to the wheel.

The *gather* is the setting forward of the end of the *spindle* so that the wheel may run freely, not pressing inordinately either on the *nut* or the *butting-ring.*

The *swing* is the setting downward of the end of the spindle so that its lower edge may be horizontal. The load resting thus, the wheel has no special tendency to slip in or out against the *butting-ring* or the *nut.*

The *swing* tips the wheel outward at top, leaning it away from the wagon, and, to enable the bearing on the *spokes, fellies,* and *tire* to be vertical, the wheel is *dished;* so that each spoke is vertical as it comes to the lower or working position. The *fellies* being set square on the *spokes,* the *tread* of the wheel is flat on the ground.

2. A flat open vessel in which food is served on table, as distinguished from a *plate* in which it is served to guests.

3. A box having a capacity of 672 cubic inches, in which ore is measured.

Dished. (*Machinery.*) Having a central depression. Hollowed, cup-shaped.

Dished-out A term applied to the sunk cradling employed in vaults, coved ceilings, and domes which are formed by wooden ribs (*bracketing*) upon which the lath and plastering are secured.

Dish-heat'er. A warming-closet attached to a stove or exposed in front of a fire to heat dishes.

Dish-hold'er. A grasping-implement for hot dishes, or for holding them while washing in very hot water.

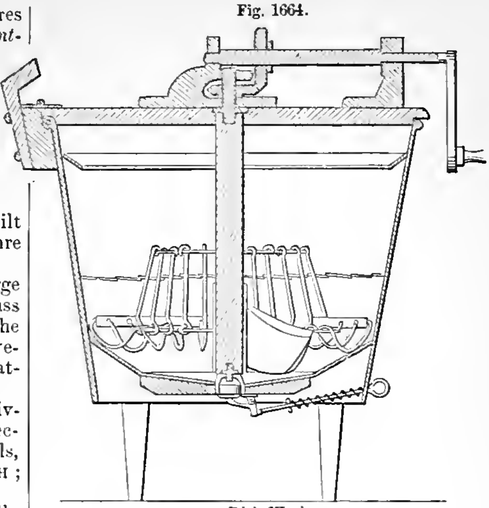
Dish'ing. (*Of wheels.*) See DISH.

Dish-rack. A frame in which dishes and plates are placed to drain and dry.

Dish-wash'er. A device by which dishes are cleaned by agitation, in some cases assisted by brushes or sponges. Among the numerous varieties may be cited the circular rack rotated in a tub with water sufficient to submerge the dishes and plates.

Dis'in-fect'or. An apparatus for disseminating a gas, vapor, or fine spray for the purification of the air and the counteraction of contagious influences.

Fig. 1664.



Dish-Washer.

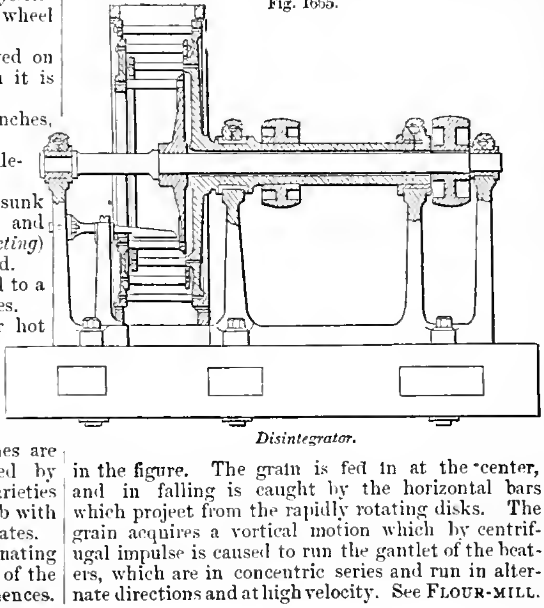
The modes are various: Atomizers for spraying; vessels in which gases are eliminated by chemical action; vapors generated by the heat of lamps beneath vessels containing the ingredients; blowers by which a medicated atmosphere is diffused; trays in which the materials are exposed to the ordinary currents of air; pastiles for burning; odors and perfumes for disguising; earth and charcoal for absorbing.

Among disinfectants may be cited chlorine, chloride of lime, carbolate of lime, carbolic acid, chloride of zinc, chloride of iron, permanganate of potash, sulphurous acid fumes, roasting coffee.

Dis-in'te-grat'or. 1. A machine for grinding or pulverizing bones, guano, etc., for manure.

2. A mill in which grain is broken into a fine dust by beaters projecting from the faces of parallel metallic disks revolving in contrary directions, as

Fig. 1665.



Disintegrator.

in the figure. The grain is fed in at the center, and in falling is caught by the horizontal bars which project from the rapidly rotating disks. The grain acquires a vertical motion which by centrifugal impulse is caused to run the gantlet of the beaters, which are in concentric series and run in alternate directions and at high velocity. See FLOUR-MILL.

Disk. One of the collars separating and fastening the cutters on a horizontal mandrel.

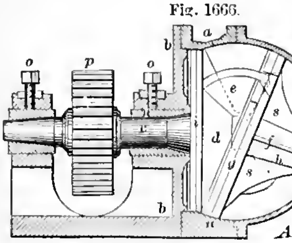
A flat circular plate.

Disk Steam-en′gine. A form of *rotary steam-engine* which was invented by Ericsson and improved by Bishopp and others.

In the *Ericsson engine* the disk *revolves*, and in the *Bishopp engine* the disk *wobbles*.

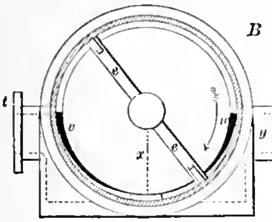
Ericsson's disk steam-engine (*A B*, Fig. 1666).

Fig. 1666.

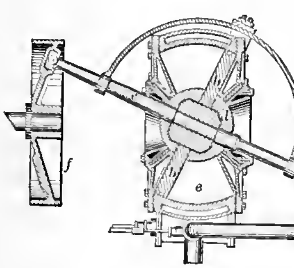


A

B



C



Disk-Engines.

The steam-chamber *a* is the segment of a sphere, and is fastened by flanges to the head *b*. *c* is the engine-shaft, having a gear-wheel *p*. On the end of the shaft is a flat cone *d*, having packing *i* around its circumference and a spherical knob at its end, which works in a corresponding cup or socket in the center of the disk *g*, which has a packing around its periphery. The disk *g* has strengthening ribs *s* and an axis running in a conical bearing *m*, which is adjusted by a set screw. A brass bearing *l* against the end of the axis forces the disk against the cone *d*, the lower side of the disk remaining in constant contact with the lower side of the cone throughout the revolution; the two contacting objects revolve in different planes by the action of the steam on the sectors *e e*. These sectors are attached to the cone and form the piston, and the point of contact of the disk and cone forms the abutment. The sectors pass through slits in the disk, sliding back and forth; occupying the whole width of the steam space at the upper portion of their stroke, and then receding as the surfaces of the disk and cone come in contact at the lower point, on the respective sides of which are the induction and eduction steam-ports.

The steam passes through the neck *t* into the spherical chamber through an opening *v* cut through its side; this opening is of triangular shape, and made as wide at top as the circular plane is there distant from the base of the cone, and gradually tapering off downward; *w* is the opening through which the steam escapes into the atmosphere, or into the condenser, as the case may be, through the neck *y*. The dotted line *x* shows where the cone and circular plane come in contact.

Steam admitted into the spherical chamber by the neck *t* and opening *v*, and being there prevented from passing the line *x* by the pressure of the disk against the cone at that place, it presses against the upper leaf *c*, which, together with the cone and disk, is thereby carried round in the direction of the arrow. When the leaf has passed the upper part of the opening *w*, the steam that has been acting upon it escapes, but at the same time the opposite leaf has passed the top of the steam-opening *v*, and is carried round in a similar manner.

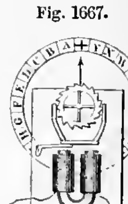
The engine has no valves, the action of the piston is at all times direct, and the engine can be stopped, started, or reversed at any position of the piston.

Bishopp's disk steam-engine (English), (*C*, Fig. 1666). The piston of this engine has the form of a disk *b* attached to a shaft *c*, which has a sphere *d* on its mid-length occupying a space between two frustums of cones which form the cylinder-heads. The center of the sphere occupies the position that would form the point of meeting to the apexes of the two cones, were they prolonged. The disk and shaft do not revolve on their axis, though the ends of the shaft describe circles, as the disk *wobbles* on the cones, keeping one radius on each side in constant contact with them respectively. An abutment is formed by a plate *e*, which divides the annular space in which the steam works, the lower portion of the disk having a radial slit which enables it to slip back and forth on the abutment-plate *e*. The steam is admitted on one side of the abutment and exhausted on the other, the live steam pushing the disk before it by crowding between it and the conical head, and causing the outer end of the arm to communicate a rotary motion to a wheel *f*, to which it is connected by a universal joint.

Disk-tel′e-graph. One in which the letters and figures are arranged around a circular plate and are brought consecutively to an opening, or otherwise specifically indicated.

The first of this class of telegraphic apparatus seems to have been that of Ronald, England, 1816. At each end of the line he had clocks beating in exact unison; at least, such was the requirement of the invention. Each clock-work rotated a disk having the letters and numerals on a circular track, and these were exposed in consecutive order at an opening in the dial, the two ends of the line showing the same letter coincidently. The sender of a message watched till the required letter came in view, then made an electric connection which diverged a pair of pith balls and drew attention to the letter. This was repeated for each letter, the parties waiting till the required letter came in its turn to the openings in the respective dials. It was a slow business, and came to naught.

Fig. 1667.

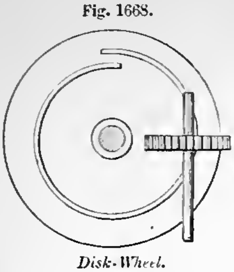


Disk-Telegraph.

Fig. 1667 shows a form of this instrument in which the armature of the magnet has two spring pieces, which act upon the ratchet-wheel as the armature vibrates to and fro, when the connection is made and broken. The pieces are respectively a *clawker* and *driver*, that is, a pulling-hook and a pushing-arm, so that each motion of the armature is made effective in moving the ratchet, and also the lettered disk.

Disk-valve. A valve formed by a perforated disk which has a rotation, partial and reciprocating,

Fig. 1668.



Disk-Wheel.

or complete, upon a circular seat whose apertures form ports for steam or other fluid.

Disk-wheel. This differs from the usual worm-wheel in the mode of presenting the spiral to the cog-wheel. In the illustration the spiral thread on the face of the disk drives the spur-gear, moving it the distance of one tooth at each revolution. The shafts are at right angles to each other.

Dis-part′. (*Gunnery.*) The difference between the muzzle and breech thicknesses of a piece of ordnance. A piece of metal is cast on the muzzle to bring the line of sight parallel to the axis of the piece, and is known as the *dispart-sight* or *muzzle-sight.*

Dis-part′-sight. A gun-sight, to allow for the dispart, and bring the line of sight and the axis of the piece into parallelism.

Dis-patch′-boat. A name given to a swift vessel, formerly a fast sailer, now a small steamboat, used in dispatch duty.

Dis-patch′-tube. A tube in which letters or parcels are transported by a current of air induced by a plenum or vacuum. See Pneumatic Tubular Dispatch; Atmospheric Railway.

Dis-place′ment. (*Of a vessel.*) The weight of water displaced, which is equal to her own weight and that of her lading.

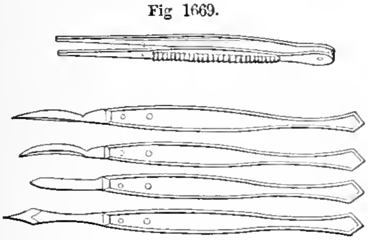
Dis-played′. (*Printing.*) Said of matter when lines are put in type more prominent than the body letter.

Dis-sect′ed Map. An educational device to teach geography. A map is pasted on to a thin board or veneer, and thus mounted is sawed apart into pieces, following the national lines of demarcation. The pieces being mixed, ingenuity and study are required to fit them all together in order.

Dis-sect′ing-for′ceps. A pair of long tweezers used in dissecting.

Dis-sect′ing-knife. The knives of the Egyptian embalmers were of an Ethiopic stone, probably flint. Herodotus describes them. A flint knife was

Fig 1669.



Dissecting-Knives.

also used by the Hebrews, Egyptians, and Ethiopians in performing the operation of circumcision. See Knife.

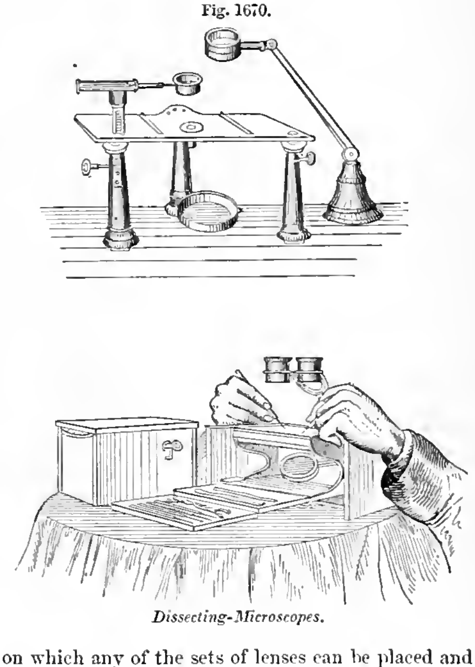
"Then Zipporah took a sharp stone and cut off the foreskin of her son, and cast it at his [Moses] feet." — *Exodus* iv. 25.

The dissection of the human body for purposes of science was ordered by Ptolemy Philadelphus in the college of Alexandria. He even authorized the vivisection of criminals condemned to death. Herophilus of Cos was among the first of the professors in this great school of medicine. The practice of dissection was very repugnant to the prejudices of the Egyptians, where to touch a corpse was defilement, as we see it also to have been among the Hebrews, who became habituated to many of the Egyptian modes of thought.

Vesalius, born at Brussels 1514, died 1564, was among the most noted of the school of modern anatomists who have pursued the study of dissection. His distinguished professional career was terminated by an unfortunate affair, which turned out to be a vivisection, as the supposed cadaver proved to be living. The relatives who had granted the dissection denounced Vesalius to the Inquisition, who would have burned him but that Philip II. stepped in and had the sentence commuted to a pilgrimage to Jerusalem. Decidedly preferable.

Dis-sect′ing-mi′cro-scope. The stage of the upper figure has rack-adjustment for focus, spring clips to hold object-slide, diaphragm, movable arm for carrying the lenses, separate jointed stand

Fig. 1670.



Dissecting-Microscopes.

on which any of the sets of lenses can be placed and used for rough or preliminary examinations; mirror on joint, three sets of doublets, of low, medium, and high power.

The lower figure is of a binocular microscope of moderate power, for anatomical and botanical investigations. It is made to close up in a box the top and front of which contain loops to hold the knives, scissors, tweezers, needles, etc. Beneath the eye-glass is a gutta-percha stage and a circle of glass illuminated by a mirror below.

Dis-solv′ing-views. Produced by the magic-lantern or the stereopticon.

Two magic-lanterns are placed side by side, their lens-tubes slightly convergent, so that each will deliver its picture upon the same portion of the screen. A tapering plate slides in front of both tubes, and is so arranged that it may shut off the aperture of either or allow a portion of the image from each to pass to the screen.

One being closed, the other is fully displayed.

Now, by moving the shutter, the image from the exhibited picture is gradually dimmed and that of the other as gradually develops. When the shutter is midway, the pictures are equally prominent and are therefore confused. The shutter continuing to move, the new picture commences to predominate, and eventually occupies the screen entirely, the other image being excluded. A change of pictures now being made in the darkened lantern, it is ready for the return motion of the shutter, which makes a similar change to that just described. The name is well given, as the pictures gradually dissolve into each other, there being no sudden removal, change, or substitution.

Dis'taff. A cleft stick about 3 feet long, on which wool or carded cotton was wound in the ancient mode of spinning. The distaff was held under the left arm, and the fibers of cotton drawn from it were twisted spirally by the forefinger and thumb of the right hand. The thread as it was spun was wound on a reel which was suspended from and revolved with the thread during spinning.

"A virtuous woman layeth her hands to the spindle, and her hands hold the distaff." — SOLOMON.

The figures in group *a*, annexed, show a party of

Fig. 1671.

Distaff, — Ladies at Work.

ladies of the Middle Ages, engaged in the duties of ladies of rank at that time. "The mistress, as with the lady in Proverbs, layeth her hands to the spindle, and her hands hold the distaff." She is represented as cutting up a piece of cloth to make into garments, while two of her maidens are at work with their distaffs.

The figure *b* is the more modern Italian.

The distaff and spindle are referred to repeatedly in the Old Testament, and were the only known means of spinning in Egypt, Phœnicia, Arabia, India, Greece, and Rome. Distaff spinning and weaving are shown at Beni Hassan, in Egypt. The Greeks represented Minerva with a distaff as being the inventress of spinning.

Catullus describes it clearly : —

> "The loaded distaff in the left hand placed,
> With spongy coils of snow-white wool was graced ;
> From these the right hand lengthening fibers drew,
> Which into thread 'neath nimble fingers grew.
> At intervals a gentle touch was given,
> By which the twirling whorl was onward driven.
> Then, when the sinking spindle reached the ground,
> The recent thread around its spire was wound ;
> Until the clasp within its nipping cleft
> Held fast the newly finished length of weft."

Dis-tem'per. A kind of painting in which whiting is used as the basis of the colors, the liquid medium being size ; it is much used for ceilings and walls. See DESTEMPER.

Dis'til-la'tion. The volatilization of a liquid and condensation in a separate vessel.

Zosimus, the Panopolitan, described the operation for the purification of water, and the Arabs called the instrument an alembic. Djafar, eighth century, obtained nitric acid and aqua regia, and Rhazes absolute alcohol and sulphuric acid. See ALEMBIC ; STILL.

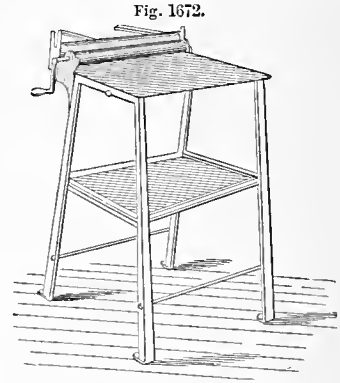
Dis-trib'ut-ing. (*Printing.*) The operation of returning from the column to the *case* the letters, etc., which made up the *matter*.

The compositor wets a page or part of a column of matter, and takes up a number of lines on his distributing-rule. The wetting causes the types to adhere slightly together. He takes a few words between his finger and thumb, and, reading the purport, by a dexterous slackening of his grip, so as to loosen the type *seriatim*, he throws the several letters into their various boxes. *Distribution* is said to be four times faster than composition. See TYPE-DISTRIBUTING MACHINE.

Dis-trib'ut-ing-res'er-voir. A small reservoir for a given district, capable of containing a volume of water equal to the whole excess of the demand for water during those hours of the day when such demand exceeds the average rate, above a supply during the same time at the average rate. The greatest hourly demand for water is about double the average hourly demand. The least that a distributing-reservoir should hold is half the daily demand.

Dis-trib'ut-ing-roll'er. (*Printing.*) A roller on the edge of an inking-table for distributing ink to the printing-roller. At the side of the table is an ink-trough which is pressed up against the *distributing-roller* by balance-weights. The distributing-roller presents a line of ink to the printing-roller, which is then run back and forth on the table to spread the supply of ink evenly around it.

Fig. 1672.



Distributing-Roller and Inking-Table.

The arrangement was invented by Professor Cowper, and is described in his English patent of 1818.

The distributing-roller in printing-machines carries ink from the *ductor-roller* to the inking-roller. To secure an even distribution, it is found necessary to give an endwise motion to the roller.

This is secured in one of two ways.

Professor Cowper's plan was to give a longitudinal motion to the axis (English patent, 1818).

Applegarth's method was to place the axis of the distributing-roller obliquely to the surface against which it moved. It thus had a *relative* endwise motion, which distributed the ink along as well as around the rollers involved in the combination.

Dis-trib'ut-ing-rule. (*Printing.*) A rule used in separating the lines of type in distribution.

Dis-trib'ut-ing-ta'ble. (*Printing.*) The slab on which the ink is spread and transferred to the rollers.

Dis'tri-bu'tion. The application of steam in the engine in respect to its induction, eduction, expansive working, etc.

Ditch. 1. (*Fortification.*) A trench or *fosse* on the outside of a fortification or earthwork, serving as an obstacle to the assailant and furnishing earth (*déblai*) for the parapet (*remblai*). It is from 90 to 150 feet broad, in regular fortifications, much narrower in mere earthworks or entrenched positions. The side of the ditch nearest the place is the *scarp* or *escarp*, and the opposite side, the *counterscarp*, is usually made circular opposite to the salient angles of the works. See BASTION.

Under the ancient system of fortification, the ditch was frequently dug on the inside, thus anticipating by some thousands of years the improvement of Pillow, during the Mexican war, —

> "He who dug for Polk and Marcy
> Ditch and rampart vi-ce var-sy."

The object of the savages is evident. It was to obtain shelter for the bodies of the archers with the least amount of labor; and by this system they most readily obtained the required shelter, having the benefit of the ditch and the bank. The Mandan Indians adopted this plan. The system is seen in the modern rifle-pit.

The *fossa* around a Roman encampment was usually 9 feet broad and 7 feet deep; but if an attack was apprehended, it was made 13 feet wide and 12 feet deep. The *agger*, or parapet, of the encampment was raised from the earth of the *fossa*, and was crowned with a row of sharp stakes. *Valli.*

The ditch outside the rampart on the western side of Rome was 100 feet wide, 30 deep. The work was constructed by Servius Tullius.

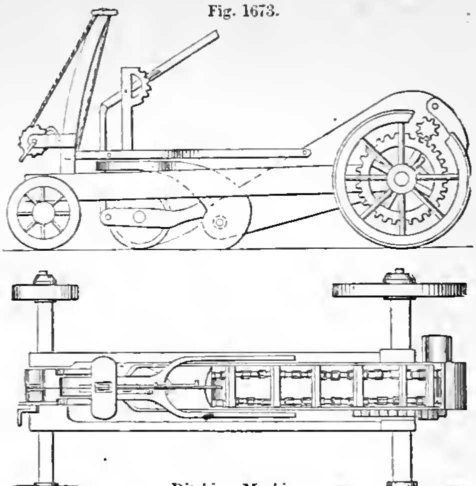
2. An artificial water-course for drainage.

By the laws of Solon (594 B. C.), no one was allowed to dig a ditch but at the same distance from his neighbor's land that the ditch was deep. This was the same in the Roman laws of the twelve tables. The Grecian law compelled one who planted common trees to place them no nearer than 9 feet from his boundary; olives, 10 feet. The law of the twelve tables made it, olives and figs 9 feet, other trees 5 feet.

The agricultural ditches of the Romans were open (*fossa patentes*) or closed (*fossa cæcæ*); the latter usually 3 feet broad at top, 18 inches at bottom. The lower portion was filled with stone or gravel, a layer of pine leaves or willows, and then the earth replaced. Sometimes a large rope of withes or a bundle of poles was placed in the bottom.

Ditch'ing-ma-chine'. One adapted to excavate a deep trench and deposit the earth at the side of the same. In this sense a plow may be a ditching-machine, and in fact is often so used in running shallow ditches for surface-draining, but it will only make it single-furrow depth. There are many modifications of the plow for attaining extra depth.

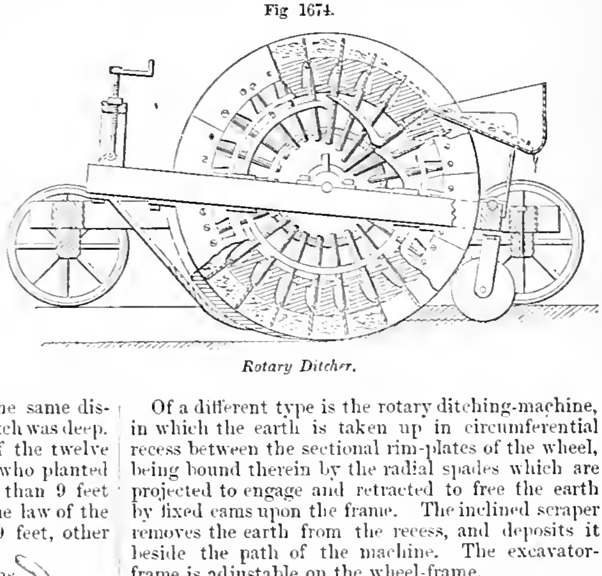
Fig. 1673.



Ditching-Machine.

In Fig. 1673, the earth is raised by a double-pointed, concave-topped plow, and the earth is compacted upon it by an adjustable roller. The earth is carried upward and backward by an endless conveyer.

Fig 1674.

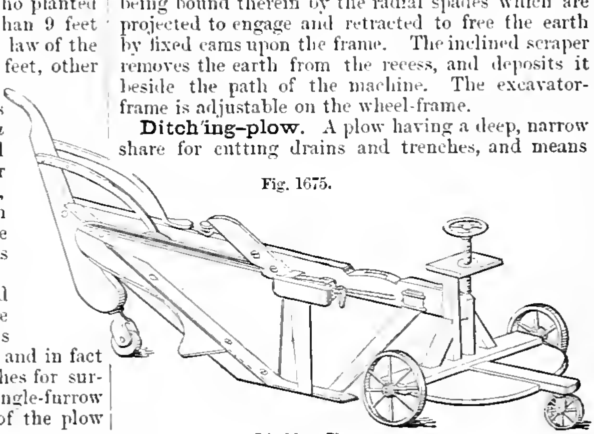


Rotary Ditcher.

Of a different type is the rotary ditching-machine, in which the earth is taken up in circumferential recess between the sectional rim-plates of the wheel, being bound therein by the radial spades which are projected to engage and retracted to free the earth by fixed cams upon the frame. The inclined scraper removes the earth from the recess, and deposits it beside the path of the machine. The excavator-frame is adjustable on the wheel-frame.

Ditch'ing-plow. A plow having a deep, narrow share for cutting drains and trenches, and means

Fig. 1675.



Ditching-Plow.

for lifting the earth and depositing it at the side or sides of the excavation. In Fig. 1675, the forward carriage straddles the ditch, and the rear supporting-wheel runs in the ditch behind the cutting and elevating mechanism. The share is supported by colters, which cut the sides of the ditch, and deliver the furrow-slice to the guides upon which it rises, and to the mold-boards which deliver it on the side of the ditch. Adjustments for varying depths are recited in the claims.

Ditch'ing-tools. Spades of various shapes for different forms and depths of ditches. Scoop-shaped for clearing out the bottoms; paring-spades for removing the turf. Level and reel-line for laying out the work. Plows, ditching-machines, and excavators for reducing the amount of hand-work.

Di-ver'sion-cut. A channel to divert past a reservoir a stream of impure or turbid water which would otherwise flow into the reservoir. A *by-wash.*

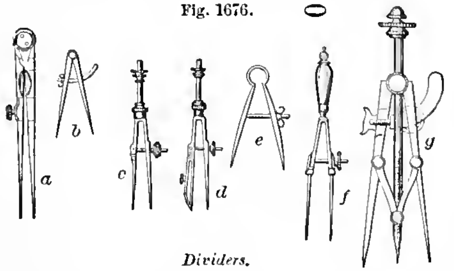
Di-vid'ed Ax'le. One bisected at its mid-length. In some instances the parts are coupled together, in others they are independent. See CAR-AXLE.

Di-vid'ed Ob'ject-glass Mi-crom'e-ter. Another name for the *double-image* micrometer. The object-glass of the telescope or microscope is bisected diametrically, the straight edges being ground smooth so that they may easily slide by each other. The halves of the bisected lens are movable in a direction perpendicular to the line of section by means of a screw; the distances being determined by the number of revolutions necessary to bring the points to be measured into optical coincidence.

Di-vid'er. (*Husbandry.*) The prow or wedge-formed piece on a reaping-machine, which divides the grain to be cut from the standing grain.

Di-vid'ers. A form of compasses, usually with an adjusting and retaining arrangement. Its name

Fig. 1676.



Dividers.

is derived from its specific use in dividing lines into any given number of equal parts. The legs are driven apart by a spring as the nut is retracted on the screw, and closed by contrary motion of the said nut; the fine thread of the screw admitting of a very delicate adjustment.

a, dividing compass.
b, dividers with arc.
c, steel spacing-dividers.
d, steel spacing-dividers with pen-leg.
e, bow-dividers.
f, spring-bow dividers, with handle.
g, bisecting-dividers.

Di-vid'ing-en'gine. A machine for dividing a circle into a number of parts of equal proportions, either for the purpose of graduation, as the circles and arcs of astronomical, surveying, and plotting instruments, or for spacing off and cutting the circumference of a wheel into teeth.

The first notice we find is in connection with a mode of originating screws by Pappus Alexandrinus, a Greek mathematician of the fourth century. His process was by a thin templet of brass of the form of a right-angled triangle, the angles of which were made in accordance with the pitch of the proposed screw. The perpendicular being wrapped around the rod at right angles to the axis, the hypoteneuse gave the spiral of the screw, and the base the pitch.

The subject of originating screws, which is closely connected with the dividing-engine, may be pursued in Holtzapffel (Vol. II. pp. 635–655).

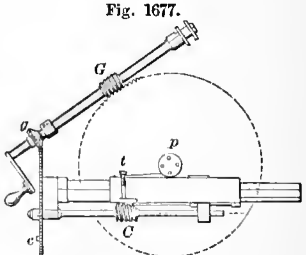
The methods of graduating instruments received much attention from Tompion (1660), Sharp (1689), the Sissons, and Bird (1745), the latter receiving £500 from the Board of Longitude for his method of dividing. Hindley, in 1740, constructed an engine for dividing circles, which also served to cut clock-wheels.

Ramsden, in 1766, contrived his dividing-engine, and in 1777 received a reward of £615 from the Board of Longitude. Following Ramsden were the Troughtons, father and son, the latter of whom received the Copley medal of the Royal Society of England for his improved method of graduation.

Ramsden's circular dividing-engine consisted of a large wheel moved by a tangent screw. The wheel was 45 inches in diameter, and had 2,160 teeth, so that six turns of the tangent-screw moved the circle one degree. The screw had a micrometer and also a ratchet-wheel of sixty teeth, therefore one tooth equaled one sixth of a minute of a degree. The diamond point always moved on one fixed radial line, by means of a swing-frame. The circumference of the 45-inch circle was originally divided into five parts, each of these into three; these were then bisected four times, dividing the wheel into 240 parts, each of which was designed to contain nine teeth.

The first application of the tangent-screw and ratchet to the purpose of graduation is stated by Holtzapffel to have been by Pierre Fardoil. See plate 23 of Thiout's "Traité d'Horlogerie," etc., Paris, 1741.

Fig. 1677.



Ramsden's Screw-Cutting Apparatus.

Fig. 1677 illustrates Ramsden's application of the principle of the engine just described in originating the screw of his dividing-engine for straight lines. The guide-screw *G* is turned by the winch, and in each revolution moves the larger tangent-wheel one tooth, winding on to the boss *p* a slip of watch-spring which carried the slide on which the tool *t* was fixed, thus cutting the screw *C*, which was at the same time rotated by the gearing *c g* from the prime shaft. The object was to cut a certain number of threads to the inch, and this was obtained by a tentative process by gradually reducing the diameter of *p* until 600 turns of the handle gave a motion of 5 inches to the tool-slide.

In the application of the screw to the graduation of mathematical scales, it is employed to move a platform which slides freely and carries the scale to be graduated, the swing-frame for the diamond-point being attached to some fixed part of the framing of the machine.

Donkin followed up the matter in 1823 in devising correctional methods for Maudslay's devices, to which we cannot devote room. See Holtzapffel, pp. 651–655.

In 1843, Mr. Sims applied self-acting apparatus to Troughton's circular dividing-engine, and an instrument of their manufacture may be seen at the Coast Survey building, Capitol Hill, Washington. It has been somewhat modified by Mr. Würdemann, of Washington, and is now driven by a small turbine in the stand. See GRADUATING-MACHINE.

Di-vid'ing-sink'er. (*Knitting-machine.*) One of the pieces interposed between *jack-sinkers*, which, being advanced while the latter are retracted, force the yarn between the needles of each pair, so that by the joint action of the *jack-sinkers* and the *dividing-sinkers* the yarn is looped on each of the needles.

Div'ing-bell. An apparatus, having some analogy in shape to a bell, in which persons may descend and remain for a while in safety beneath the surface of the water.

The analogue, in the natural world, of the diving-bell, is found in the contrivance of the diving-spider, whose submerged habitation has been described by De Geer. These spiders spin in the water a cell of strong, closely woven white silk, in the form of a diving-bell or half a pigeon's egg. This is sometimes quite submerged, at others partly above the water, and is always attached to some objects near it by a number of irregular threads. It is closed all round, but has a large opening below, which is closed when the insect is hibernating.

The diving-bell is said to have been used in Phœnicia 320 B. C. This was about twelve years after the capture of insular Tyre by Alexander, and perhaps was used in the recovery of valuables thrown into the sea to prevent capture by "young Ammon."

Aristotle (350 B. C.) speaks of a kind of kettle by which divers could supply themselves with fresh air under water. It is related by Jerome that Alexander the Great entered into a vessel, called a *co'lympha*, having a glass window to it, and in which he descended to the bottom of the ocean.

The application of the diving-bell in Europe is noticed by John Tasnier, who attended Charles V. in a voyage to Africa. He relates that he saw "at Toledo, in Spain, in the year 1538, in the presence of the emperor and several thousand spectators, two Greeks let themselves down under water in a large, inverted kettle, with a light burning, and rise up again without being wet.

After this period, the use of the diving-bell became generally known, and is noticed in the "Novum Organum" of Sir Francis Bacon, published 1620; in which the device is referred to as being in use in his time. It is described as a machine used to assist persons laboring under water upon wrecks, by affording a reservoir of air to which they may resort whenever they require to take breath. "A hollow metallic vessel was let down evenly to the surface of the water and carried down the air it contained. It stood upon three feet like a tripod, which were in length somewhat less than the hight of a man, so that the diver, when he was no longer able to contain his breath, could put his head into the vessel, and, having breathed, return again to his work."

The next use of the bell was in 1642, in America, when Bedall of Boston used submerged weighted "tubs," in which he descended to the "Mary Rose," which had sunk the previous year. The lifting-arrangements were completed by means of the diving-bell, and the loaded vessel transported to shoal water and recovered.

In the year 1687, the sum of £300,000 was recovered by a diving-bell, at a depth of 7 fathoms, from a Spanish ship which had been wrecked near the Bermudas. The bell was the invention of William Phipps, an American of Pemaquid, in that part of the Colony now known as the State of Maine. Phipps was brought up as a ship-carpenter in Boston, and made many unsuccessful attempts to interest parties in the work. When he succeeded, James II. was urged to confiscate the £16,000 which came to the share of William Phipps; for once in his life the king refused to do a mean thing. Phipps was afterwards made high-sheriff of the Colony, was knighted, and subsequently was governor.

The English patent of John Williams, 1692, is for an "engine for carrying four men 15 fathoms or more under water in the sea, whereby they may work twelve hours together without any danger." It is stated to be useful in raising sunken vessels. It had a submerged chamber, communicating with the surface by a rigid tube, up and down which persons might pass. Projecting sleeves and hooks afforded means for directing grapnels to sunken property.

Beckmann mentions a print in Vegetius on War, published in 1511 and 1532, representing a diver with his cap, from which rises a long leather pipe provided with an opening above the surface of the water. Lorini on Fortification, 1607, shows a square box, bound with iron, furnished with windows and a seat for the diver. Kessler in 1617, Witsen in 1671, and Borelli in 1679, gave attention to the subject and contributed to the efficiency of the apparatus.

A diving-bell company was formed in England in 1688, and the operators made some successful descents on the coast of Hispaniola. In 1664, cannon were recovered from wrecks of the Spanish Armada by the Laird of Melgim, near the Isle of Man, but not sufficient to pay. Previous unsuccessful attempts had been made by Colquhoun, of Glasgow, who depended for air upon a leathern tube reaching above the surface of the water. Dr. Halley, in 1715, improved the diving-bell by a contrivance for supplying it with fresh air by means of barrels lowered from the vessel, from which the bell was suspended, the foul air escaping by a cock. This also allowed the bell to be completely filled with air, rendering the whole of its interior space available. Halley also invented a waterproof cap to which pipes leading to the bell were attached, so that an operator could leave the bell and walk on the bottom outside, being supplied with air by the pipe. This resembled in some respects the modern submarine armor, helmet, and diving-dress, which had been in occasional use since early in the sixteenth century (*ut supra*). Spalding, in 1774, made farther improvements by suspending a balance-weight from the bell that on striking bottom took off the weight of the bell, which with its included air, being too light to sink, was more readily raised or lowered by the admission of air or water into an upper compartment, placing it completely under the control of those within it. For this the British Government decreed him a reward. The celebrated engineer Smeaton, about the year 1779, first used it for engineering purposes, and in 1788, having to prepare the foundation for the pier in Ramsgate Harbor, he contrived a bell by which the work was very greatly facilitated. This consisted of a nearly conical box of cast-iron, of great weight and solidity, capable of containing 50 cubic feet of air, or sufficient for two persons one hour; this was constantly charged by means of a pipe leading to a force-pump above. The diving-bell has been subsequently applied with great success to many important submarine engineering operations, and for the purpose of recovering valuables from shipwrecked vessels, etc., but of late years seems to be nearly superseded by the recent improvements in submarine armor. The principle of the diving-bell may be illustrated by taking a tumbler, inverting it, and pressing it down into a vessel of water, when it will be seen that, although the water will rise in the tumbler to an extent proportioned to its degree of immersion, yet the upper part of the tumbler will remain perfectly dry, and if a lighted taper be placed within, it will not be extinguished, but will, on the contrary, burn with even increased energy, owing to the condensation of the air by pressure. Mr. Brunel found that at the depth of 30 feet he could hold his breath two minutes, or double the usual time, the amount of air taken into the lungs at one inspiration being in fact double what it would have been at the surface.

Dr. Faraday relates the curious fact, that the lungs are, in their natural state, charged with a large quantity of impure air; this being a portion of the carbonic-acid gas which is formed during respiration, but which, after such expiration, remains lodged in the involved passages of the pulmonary vessels. By breathing hard for a short time, as a person does after violent exercise, this impure air is expelled, and its place is supplied by pure atmospheric air, by which a person will be enabled to hold his breath much longer than without such precaution. Dr. Faraday states that, although he could only hold his breath, after breathing in the ordinary way, for about three quarters of a minute, and that with great difficulty, he felt no inconvenience, after making eight or ten forced respirations to clear the lungs, until the mouth and nostrils had been closed more than a minute and a half; and that he continued to hold breath to the end of the second minute. A knowledge of this fact may enable a diver to remain under water at least twice as long as he otherwise could do.

The experience of a French diver, who descended for the purpose of examining the wreck of a steamer sunk off Ushant in 1865, is interesting. He found that at the depth of 195 feet the general pressure over the whole body was so great that the bladder was involuntarily emptied. At this depth he rested on the sands in which his feet sunk. He detaches one end of the guide-cord; he can distinguish this cord, the weights, and his hands, and he advances a few steps. He has great difficulty in withdrawing his feet from the sands, to which he feels rooted. All at once his sight is obscured, his head turns; he returns instinctively to the ladder, and asks to be raised. He begins to ascend as well as his strength will allow, feels himself impeded by his guide-cord, which he cuts, and then rises alone very rapidly, having lost his senses. A violent shock brings him to; he recognizes the side of the ship from which he had descended, against which his mask has struck, and regains his courage. He waves his hand above the surface of the water, and feels himself sinking. His mask having got displaced, the collar almost chokes him. He feels himself grasped by the arms, and grasps a rope which his hand happened to touch. He again loses consciousness for a moment in the ship's boat, and asks to be raised on deck as soon as his mask shall be unscrewed. He suffers much from his right hand, and breathes with difficulty; his extremities are cold and neck painful. Twice he nearly faints and ceases to breathe. His sight appears troubled, everything turns round with him, and his gaze has no steadiness. This, as the idiom shows, is the French account, and is preferably given without impairing its graphic character. The conclusion arrived at on this occasion was, that it was impracticable to work for any length of time at a depth exceeding 130 feet.

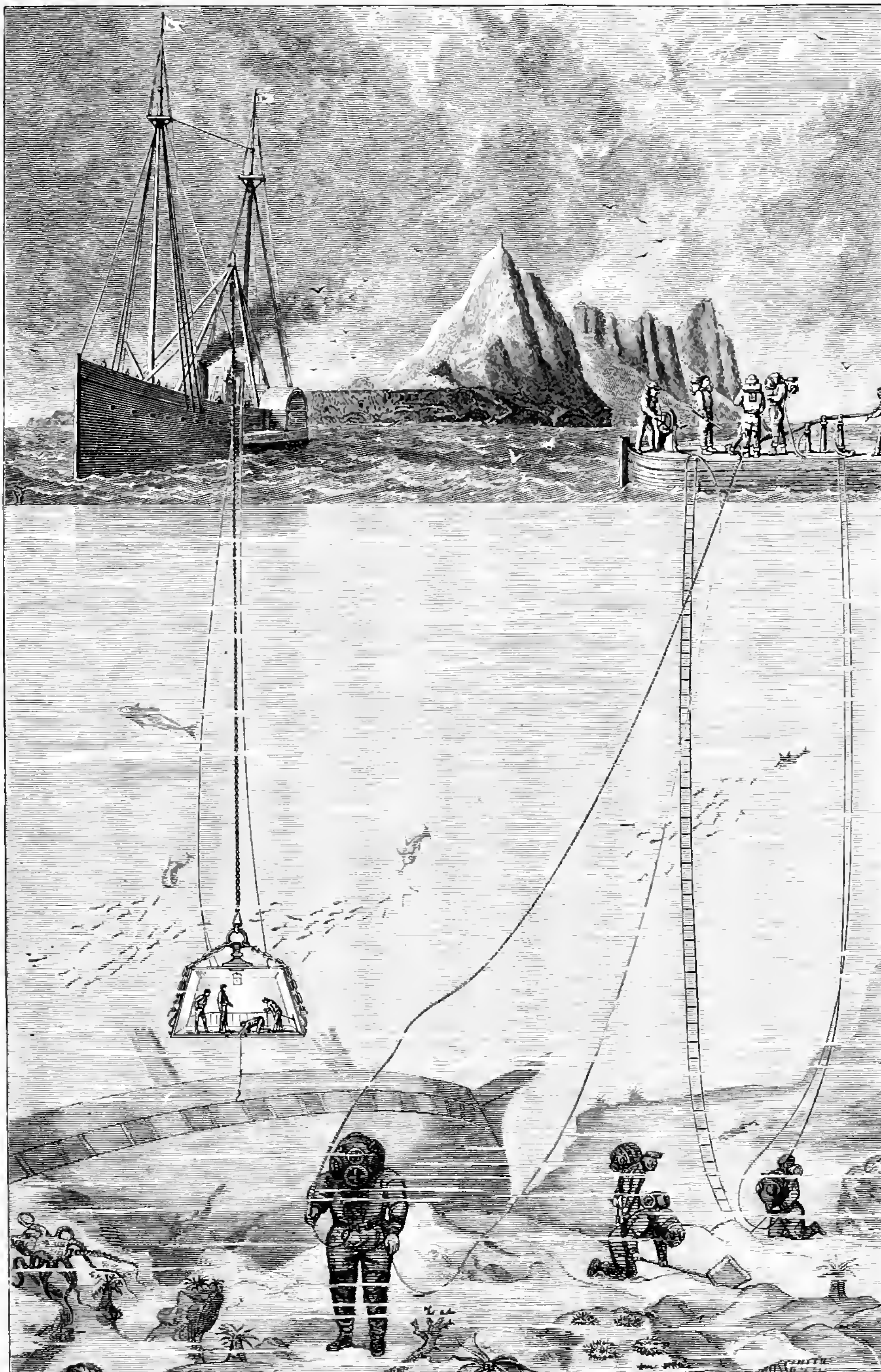
In 1869, however, the ship "Hamilla Mitchell" was lost on the Leuconia rocks, near Shanghai; and two English divers, provided with the apparatus of Siebe and Gorman, were subsequently sent from Liverpool to attempt the rescue of the treasure on board. One of these succeeded in remaining four consecutive hours under water at the depth of 23 fathoms upon one occasion, during which he recovered 64 boxes of specie.

The engraving on the opposite page illustrates submarine operations at the anchorage off Gibraltar, as conducted with the diving-bell in conjunction with divers arrayed in the apparatus of Ronquayral and Denayrouze. In this, whether the man be naked or covered with impervious clothing, his respiration may be made to depend on the exercise of his own will and the power of his lungs, or the air-supply reservoir may be supplied by air-pumps above, as shown in the figure. The artificial lung or air-supply regulator consists of a strong metallic reservoir, preferably steel, capable of resisting great pressure, and surmounted by a chamber so constructed as to regulate the efflux of air. This is carried on the diver's back. A respiratory tube issues from the chamber, and is terminated by a mouthpiece of sheet caoutchouc, which is held between the lips and teeth of the diver. This pipe is furnished with a valve, which permits the expulsion of air, but opposes the entrance of water. The steel reservoir is separated from the air-chamber by a conical valve opening from the air-chamber toward the reservoir, so as to open only under the influence of an exterior pressure, the tendency of the pressure of the air in the reservoir being to keep it closed.

This apparatus dispenses with the necessity for keeping the air-pump in continual operation. The air which the diver inhales is stored up in the steel reservoir, and from this he supplies himself without fatigue in the following manner. The air-chamber is closed by a movable lid, to which is attached the stem of the valve before referred to. The diameter of the lid is somewhat less than the interior diameter of the chamber, and it is covered with caoutchouc, to render it air-tight. It yields to both interior and exterior pressure, the former causing it to rise and the latter to fall. When exterior pressure is exerted on this lid, the valve is opened, establishing a communication between the reservoir and the air-chamber, allowing a portion of the compressed air in the reservoir to flow into the chamber. If the latter contains an excess of air, its pressure against the movable lid keeps the valve closed.

The apparatus, when under water, works in the following manner. In the act of inhalation, the diver withdraws a certain amount of air from the chamber; exterior pressure is then exerted on the movable lid, which falls, causing the conical valve to open. Air passes in from the reservoir, reëstablishing an equilibrium of pressure between the interior of the air-chamber and the surrounding water, and the conical valve returns to its seat, intercepting the communication between the reservoir and chamber until another inspiration causes the operation to be repeated. As the air is expelled from the lungs, the valve of the respiratory tube before described permits its escape into the water.

It is evident that the uniformity of action in this apparatus depends entirely upon the respiration of the diver, however irregular may be the action of the air-pump; the workman receives precisely the quantity of air he requires, and at a pressure exactly equal to that of the medium by which his body is sur-



DIVING-BELL AND CORAL-DIVERS.

PLATE XIV. GIBRALTAR. *See page* 714.

rounded. The pump which supplies air to the reservoir is so constructed that liability to leakage diminishes with the pressure, and the air is compelled to traverse two layers of water before entering the reservoir, rendering it much cooler than it would otherwise be in its greatly compressed state; it is farther cooled by expansion in passing from the reservoir into the air-chamber.

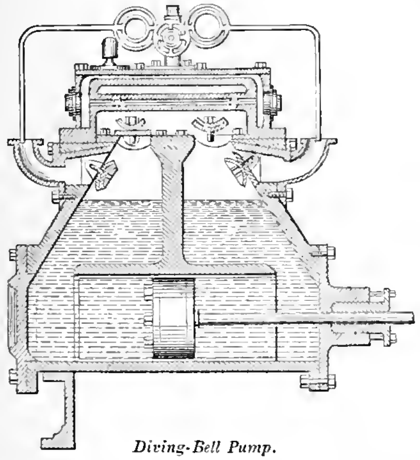
An important advantage possessed by this apparatus is that the expired air rises in bubbles to the surface. So long as the diver breathes regularly, the intervals between the appearance of the bubbles is sensibly equal. If they come more rapidly or more slowly than usual, it is a sign that something abnormal is going on. If they cease altogether, the diver must have ceased breathing, and should be hauled up immediately.

In the old forms of diving-dress the air filled the space between the body of the diver and his impervious clothing, the expired air escaping by a small valve in the helmet, through which any excess of air also escaped. Irregularity in the action of the pump caused also irregularities in the escape of the bubbles, and thus the assistants might for a long time unconsciously continue to send air to a corpse. In the new apparatus, the appearance of the bubbles indicates the safety of the diver, and the assistants on the watch are at any time warned of his danger by their nonappearance.

The armor employed in connection with the breathing-apparatus only serves to defend the diver from cold, and may therefore be made much lighter, allowing greater freedom of motion. See ARMOR, SUBMARINE.

Div'ing-bell Pump. A pump having a casing divided by a vertical partition into two chambers,

Fig. 1678.



Diving-Bell Pump.

which are provided with inwardly and outwardly opening valves. The chambers are kept partially filled with water, which, together with air, is admitted to each through the inwardly opening valves, and expelled through those opening outwardly, to supply the bell with fresh air. This is effected by the alternate reciprocations of a piston working in the open-ended cylinder, which, at each stroke, draws a portion of the water from one of the chambers into the cylinder, lowering its level in that chamber, and permitting the air to enter through the inwardly opening valve; the return-stroke causes the water to rise, forcing some of it, together with the air, into an exterior chamber, whence it is carried to a condenser, and thence, through a tube, to the bell.

Div'ing-dress. A waterproof clothing and helmet for those who make submarine explorations. See ARMOR, SUBMARINE.

Di-vis'ion-plate. The disk or wheel in the gear-cutting lathe, which is pierced with various circular systems of holes; each circle represents the divisions of a circumference into a given number of parts.

Do'be-rein'er's Lamp. An instrument invented by Professor Dobereiner, in Jena, in 1824, for obtaining light by the projection of a jet of hydrogen upon a piece of spongy platinum. See HYDROGEN LAMP.

Dock. 1. (*Hydraulic Engineering.*) An artificial excavation or structure for containing a vessel for repairs, loading, or unloading.

Docks are of various kinds. See

Wet-dock.	Floating-dock.
Dry-dock.	Hydraulic-dock.
Graving-dock.	Slip-dock.
Screw-dock.	Shipbuilding-dock.
Sectional-dock.	

The docks (*navalia*) of Rome were used for building, laying up, and refitting ships. They were attached to the emporium outside of the Porta Trigemina, and were connected with the Tiber. They were included within the walls of the city by Aurelian.

The Athenian docks in the Piræus cost 1,000 talents.

"They have a design to get the king [Charles II.] to hire a dock for the herring busses to lie up in." — PEPYS, 1661.

"Sir N. Crisp's project of making a great sasse [sluice or lock] in the king's lands about Deptford, to be a wett dock to hold 200 sail of ships." — IBID, 1662.

Of the docks of London: —

Pitt laid the foundation-stone of the "West-India" August 15, 1800; opened in 1802. "London" docks, built 1802–5. "Victoria," 1855. The Liverpool and Birkenhead docks, 1810–57.

2. (*Harness.*) The divided piece forming part of the crupper, through which the horse's tail is inserted.

Dock'er. A stamp for cutting and piercing dough in making crackers or sea-biscuit.

Doc'tor. A part in a machine for regulating quantity, adjusting, or feeding: —

a. (*Paper-making.*) A steel edge on the pressure-roll of a paper-machine to remove any adhering fibers.

b. (*Steam-engine.*) An auxiliary steam-engine to feed the boiler.

c. (*Calico-printing.*) A scraper to remove superfluous coloring-matter from the cylinder.

The *color-doctor* of a calico-printing machine, which wipes superfluous color from the face of the engraved roller.

The *lint-doctor,* which removes fluff and loose threads from the said roller.

The *cleaning-doctor,* which wipes clean the surface of the roller.

Dod. (*Tile-making.*) A piece affording an annular throat through which clay is forced, to make drain-pipe. See TILE-MACHINE.

Dodg'ing. Said of mortises, when they are not in the same plane at the hub. By spreading the butts of the spokes where they enter the hub, *dodging* on each side of a median line, alternately, the wheel is stiffened against lateral strain. The wheel is said to be *staggered.*

Doe'skin. (*Fabric.*) A single width fine woolen cloth for men's wear; not twilled.

Dof'fer. A comb or revolving card-covered cylinder in a carding-machine, which strips the fleece or sliver of fiber off the main card-wheel after the filaments have passed the series of smaller carding-rollers and the flat cards.

It is usually a comb with very fine teeth, which penetrate slightly between the wire teeth of the card as the comb moves downward.

Doff'ing-cyl'in-der. A cylinder clothed with cards which are presented in such direction and at such a rate of motion to the main card-cylinder as to remove the fibers from the teeth of the latter.

The doffing-cylinder assumes one of three forms:—

1. *Continuous clothing;* removing a perfect fleece of the width of the machine. Such is the *doffer* of the *scribbling-machine,* which yields a continous *lap* or *fleece.*

2. *Longitudinal bands of card clothing;* removing slivers of a width determined by the breadth of the bands and of a length equal to that of the *doffer.* Such is the doffer of the *slubbing-billy.* See SLUBBING-MACHINE.

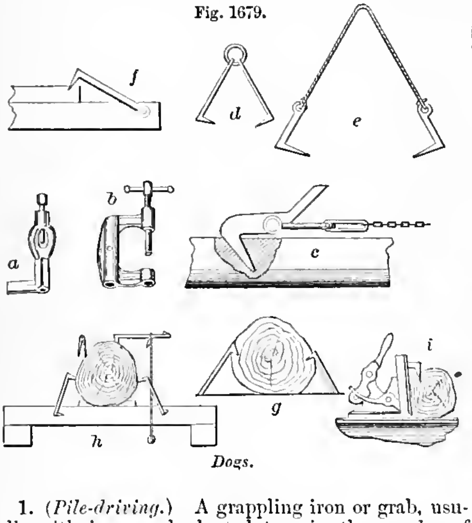
3. *Circumferential bands or rings of card-clothing;* removing narrow, continuous slivers, which pass to the *condenser,* whereby they are compacted and brought to the condition of *slubs.* Such is the *doffer* of another form of SLUBBING-MACHINE (which see).

Doff'ing-knife. A blade of steel toothed at its edge like a fine comb, and vertically reciprocated by a crank tangentially to the teeth of the *doffer* in a carding-machine, in order to remove therefrom a fine fleece of carded wool which is gathered into a sliver. See DOFFER.

Dog. A hold-fast.

A device with a tooth which penetrates or grips an object and detains it. The analogy and inference of the name is that the device has a *tooth* and *bites.*

Fig. 1679.



Dogs.

1. (*Pile-driving.*) A grappling iron or grab, usually with jaws, and adapted to raise the *monkey* of a pile-driver. When the jaws open, the object is dropped or released. See PILE-DRIVER.

2. (*Well-boring.*) A grab for clutching well tubes or tools, in withdrawing them from bored, drilled, or driven wells. See GRAB.

3. (*Turning.*) A clamp fastened to a piece suspended on the centers of a lathe, and by which the rotation of the chuck or face-plate is imparted to the piece to be turned (*a b,* Fig. 1679).

4. A *click* or *pallet* adapted to engage the teeth of a ratchet-wheel, to restrain the back action. A *click* or *pawl.* See WINDLASS; RATCHET.

5. (*Machinery.*) *a.* The converging set screws which establish the *bed-tool* of a punching-press in direct coincidence with the punch.

b. A contrivance for holding the staff to the rest, chuck, or carriage, while being cut, sawed, planed, or drilled.

c. An adjustable stop placed in a machine to change direction of motion, as in the case of feed-motion, or in *jacking, shaping,* or *planing* machines.

6. (*Hoisting and Hauling.*) *a.* A grappling-iron (*c*) with a fang which is driven into an object to be raised or moved.

In the continuous system of feed in saw-mills, the chain has a number of dogs attached to different portions of its length. Dogs are also used for securing and towing floating logs and in shifting or loading logs on the ground or carriage.

b. A *ring*-dog or *span*-dog (*d*); two dogs shackled together by a ring, and used for hauling or hoisting.

c. *Sling*-dogs (*e*); two dogs at the end of a rope and used in hoisting barrels. A *span-shackle.*

7. A *bench*-dog (*f*) is a clamp, and holds the timber by its tusk.

8. (*Sawing.*) A rod on the head or tail block of a saw-mill carriage, by which the log is secured in position. The dog (*g*) is pivoted to the block, and its tooth is driven into the log. It varies in form on the head and tail blocks respectively.

In *h* and *i* respectively are shown other forms of the saw-mill dog. See also CIRCULAR SAW; HEAD-BLOCK.

9. (*Shipbuilding.*) The last detents or supports knocked away at the launching of a ship. A *dog-shore.*

10. (*Locksmithing.*) A projection, tooth, tusk, or jag in a lock, acting as a detent. Especially used in tumbler-locks.

11. An *andiron.*

Dog and Driv'er Chuck. A chuck having two parts. The dog slips upon and is fastened by a set screw to the object to be turned. The driver is attached to the lathe-mandrel, and has a projecting arm which comes in contact with the dog, and causes it and the work to revolve with the mandrel. See DOG (*a b,* Fig. 1679).

Dog-bolt. The bolt of the cap-square over the trunnion of a gun.

Dog-cart. A sportsman's vehicle having shafts and two wheels, with a box beneath the seat for setters or pointers.

Dog'ger. (*Nautical.*) A two-masted fishing-vessel with bluff bows and used on the Dogger Bank, an extensive shoal in the center of the North Sea. It is about 80 tons burden, and has a well in the middle to bring fish alive to shore.

Dog-hook. 1. A bar of iron with a bent prong to drive into a log. See DOG.

2. A wrench for unscrewing the coupling of iron boring-rods. A *spanner.*

Dog-leg Chis'el. A crooked-shanked chisel used in smoothing the bottoms of grooves.

Dog-legged Stairs. A flight of stairs without any well-hole, and used in confined situations. The flight goes up, winds in a semicircle, and then mounts again in a direction parallel to the first.

Dog-muz'zle. A wire cage over the nose and jaws, to keep a dog from biting; or a strap around the jaws, to keep them shut.

Dog-nail. A large nail with a projecting tooth or lug on one side; used under certain circumstances by locksmiths and carpenters.

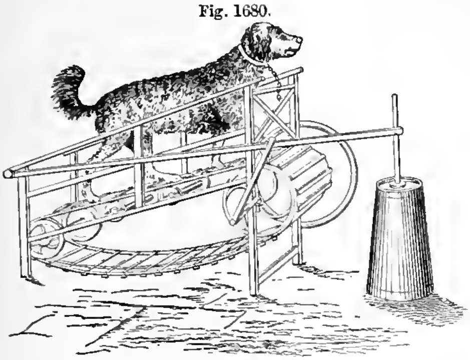
Dog-nose Vise. (*Locksmithing.*) A hand-vise with long, slender, pointed jaws. Called also *pig-nose* vise.

Dog-pow′er. A machine by which the weight of a dog in traveling in a drum or on an endless track is made to rotate a spit, or drive the dasher of a churn.

The turnspit-dogs of the last and previous centuries ran on the inside of a hollow tread-wheel, which rotated with their weight and communicated motion by a band to the spit. See ROASTING-JACK.

In the modern dog-powers, as in the example, the animal walks on an endless chain-track, which slips

Fig. 1680.



Dog-Power.

to the rear, rotating a drum which oscillates an arm, and vertical reciprocation is given to a lever and the churn-dasher.

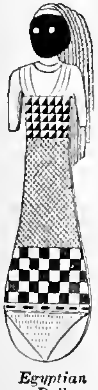
Dog-shore. (*Shipbuilding.*) One of the two struts which hold the cradle of the ship from sliding on the slip-ways when the keel-blocks are taken out. The lower end of each *dog-shore* abuts against the upper end of the *rib-band* of the *slip-way*, and the upper end against the *dog-cleat*, which is bolted to the side of the *bilge-way*. Beneath each *dog-shore* is a small block called a *trigger*.

In launching, the triggers are removed, the *dog-shores* knocked down, and the ship-*cradle* freed, so that, carrying the vessel, it slides down the *slip-ways*. The signal for launching is, "Down dog-shores." See LAUNCH.

Dog's-tooth. A sharp steel punch used by marble-workers.

Dog-stop′per. (*Nautical.*) A stopper put on to the cable to enable it to be bitted, or to permit the *messenger* to be *fleeted*.

Fig. 1681.



Egyptian Doll.

Dog-vane. (*Nautical.*) A small vane, made of cork and feathers, placed on the weather-rail as a guide to the helmsman when sailing on a wind.

Doi′ly. (*Fabric.*) Formerly, a species of woolen stuff; now, a table-napkin.

Doll. A child's toy-baby. Made of stuffed cloth, wood, india-rubber, etc. The jointed wooden dolls are a marvel of cheapness, and are made by the peasantry of Europe. See TOY.

Among other curiosities of the former inhabitants of Egypt are a number of dolls which are found in the tombs, and also are represented on the painted walls. Just as with us, some are rough, some comical, and some are made as nearly symmetrical as the artist was able.

Dol′ly. 1. (*Metallurgy.*) A perforated board placed over a tub containing ore to be washed, and which, being worked by a winch-handle, gives a circular motion to the ore.

2. (*Piling.*) An extension-piece on the upper end of a pile, when the head of the latter is beyond the reach of the *monkey*. Otherwise called a *punch*.

3. A hoisting-platform.

4. A tool with an indented head for shaping the head of a rivet. A *snap-head*.

Dol′ly-bar. A block or bar in the trough of a grindstone which is lowered into the water to raise the latter against the face of the stone by displacement.

Dol′ly-tub. (*Metallurgy.*) A vertical tub in which metalliferous slimes are washed. It has a vertical shaft and vanes turned by a crank-handle, like some kinds of churns.

Dol′phin. 1. (*Ordnance.*) One of the handles of an old-fashioned brass gun, nearly over the trunnions, and by which it is lifted.

2. (*Nautical.*) *a.* A bollard post on a quay to make hawsers fast to.

b. An anchored spar with rings, serving as a mooring-buoy.

c. A strap of plaited cordage acting as a preventer on a yard, to sustain it in case the slings are shot away.

3. (*Hydraulics.*) The induction-pipe of a water-main, and its cover, placed at the source of supply.

Dol′phin-strik′er. (*Nautical.*) A spar depending from the end of the bowsprit. It affords a strut for the martingales of the *jib-boom* and *flying-jib-boom*.

Dome. 1. (*Architecture.*) A vault on a circular plan. It is usually hemispherical in form, but is susceptible of a prolonged or oblate spheroidal variation.

In the data following, the hight given is that of the apex above the ground.

The dome of the Pantheon at Rome is a hemisphere 142 feet in diameter, 143 feet high above the floor of the rotunda.

The dome of St. Sophia at Constantinople is an oblate semi-spheroid 104 feet in diameter, 201 feet high. It is said to be built of earthenware and pumice-stone, not of cut stone. It was built in the sixth century.

The dome in the Duomo of Florence was built by Brunelleschi in 1417. It is of brick, octagonal in plan, 139 feet in diameter, and 310 feet in hight.

The dome of St. Peter's, at Rome, was built at the close of the sixteenth century, from designs left by Michael Angelo. It is 139 feet in diameter, 330 feet high.

The dome of St. Paul's, at London, by Sir Christopher Wren, is not masonry, but a shell inclosing the brick cone which supports the lantern. It is 112 feet in diameter, 215 feet high.

	Internal Diameter.	Internal Hight.
Mosque of Achmet, Constantinople	92	120
Duomo at Milan	57	254
Hall aux Blés, Paris, by Moulineau	200	150
St. Isaac's, Petersburg	96	150
Baths of Caracalla	112	116

The dome of the Capitol, Washington, is 287 feet 11 inches above the base-line of the east front. The greatest diameter of the dome at the springing is 135 feet 5 inches. The weight of iron in the dome and tholus is 8,009,200 pounds. The rotunda is 95.5 feet in diameter, and its hight from the floor to the top of the canopy is 180.25 feet.

The central rotund of the Vienna Exposition building, 1873, springs from a circular façade of piers 426½ feet, English, in diameter; within which is a gallery covered with its own roof; from the interior perimeter of the gallery rises a conical roof surmounted by a lantern 105 feet in diameter, and this by a second lantern and cupola rising to a hight of 300 feet above the ground.

2. (*Steam-engine.*) The steam-chamber above some forms of boilers, as the locomotive. It frequently has an arched crown.

3. (*Railroad.*) The elevated upper section of a passenger-car projecting above the general level of the roof, forming a space for ventilation, light, and ornament.

Dome-cov'er. (*Steam-engine.*) The brass or copper cover over the dome of a locomotive, which serves to prevent the radiation of heat.

Do-mes'tic. (*Fabric.*) Bleached and unbleached, unprinted and undyed cotton cloths of the ordinary grades for common use.

Do-mes'tic Ap-pli'an-ces. The implements and conveniences appertaining to the household. Among them are the following, which are considered under their respective heads: —

Almond-peeler.
Andiron.
Apple-corer.
Apple-parer.
Apple-quarterer.
Ash-leach.
Ash-sifter.
Baby-jumper.
Baby-walker.
Baker.
Basket.
Bean-sheller.
Bed.
Bed-bottom.
Bedstead.
Bedstead-fastener.
Bird-cage.
Biscuit-machine.
Boiler. Culinary
Boot-jack.
Bottle-cleaner.
Bottle-screw.
Bread-cutter.
Bread-making machine.
Broiler.
Broom.
Broom-handle.
Broom-head.
Brush. See Brushes.
Butter-dish.
Butter-mold.
Butter-tongs.
Butter-worker.
Cake-cutter.
Cake-mixer.
Candle-snuffers.
Can-opener.
Carpet-beater.
Carpet-cleaner.
Carpet-fastener.
Carpet-stretcher.
Carpet-sweeper.
Caster.
Carving-table.
Chair.
Chamber-closet.
Charcoal-furnace.
Cheese-cutter.
Cherry-stoner.
Chopping-machine.
Clothes-brush.
Clothes-dryer.
Clothes-frame.
Clothes-horse.
Clothes-line.
Clothes-line hook.
Clothes-line reel.
Clothes-pin.
Clothes-press.
Clothes-sprinkler.
Clothes-tongs.
Clothes-wringer.
Coal and ash sifter.
Coal-scuttle.
Coat-hook.
Coffee-mill.
Coffee-pot.
Coffee-roaster.
Colander.
Comb.
Comb-brush.
Cooking-range.
Cooking-stove.
Corer and slicer.
Cork-press.
Cork-pull.
Corkscrew.
Corn-cake cutter.
Corn-grater.
Corn-popper.
Couch.
Cracker-machine.
Cradle.
Cream-freezer.
Crimper. Hair
Crimper. Ruffle
Crumb-remover.
Curling-iron.
Desk.
Dish-heater.
Dish-holder.
Dish-rack.
Dish-warmer.
Dish-washer.
Docker.
Domestic-press.
Door-mat.
Dough-kneader.
Dough-mixer.
Dough-trough.
Dredging-box.
Dumb-waiter.
Dust-pan.
Earth-closet.
Egg-assorter.
Egg-basket.
Egg-beater.
Egg-boiler.
Egg-carrier.
Egg-detector.
Egg-tongs.
Extinguisher. Fan.
Feather-renovator.
Fender. Fire-irons.
Fire-screen.
Fish-kettle.
Fish-slice.
Flat-iron.
Flat-iron heater.
Flour-sifter.
Fluting-iron.
Fluting-machine.
Foot-stool.
Fork.
Freezer. Fruit-jar.
Frying-pan.
Furniture-pad.
Furniture-spring.
Furniture-tip.
Gong. Grater.
Griddle.
Gridiron.
Hastener.
Hat-rack.
Head-rest.
Hearth-brush.
Honey-strainer.
Hospital-bed.
Ice-chest.
Ice-cream freezer.
Ice-crusher.
Ice-cutter. Ice-pick.
Ice-pitcher. Ice-plane.
Ice-safe. Ice-tongs.
Ironing-board.
Ironing-machine.
Italian-iron.
Jar. Fruit
Kneading-machine.
Knife-board.
Knife-cleaning machine.
Knife-polisher.
Knife-rest.
Knife-sharpener.
Knock-down chair.
Ladle.
Lamp-chimney cleaner.
Lamp-chimney tongs.
Lamp-stove.
Laundry.
Laundry-stove.
Lemon-squeezer.
Line-clamp.
Looking-glass.
Mangle. Mat.
Matches. Match-safe.
Mattress.
Meal-sieve.
Meat-chopper.
Meat-crusher.
Meat-cutter.
Meat-hook.
Meat-mangler.
Meat-saw. Meat-spit.
Meat-tub.
Milk-can.
Milking-machine.
Mincing-knife.
Mincing-machine.
Mop.
Mop-head.
Mop-wringer.
Music-stand.
Musquito-bar.
Musquito-canopy.
Night-chair.
Nut-cracker.
Nutmeg-grater.
Oyster-opener.
Palliasse.
Peach-parer.
Peach-stoner.
Pea-sheller.
Percolator.
Piano-stool.
Pie-board.
Pillow.
Pinking-iron.
Piping-iron.
Plate-rack.
Plate-warmer.
Pliant.
Portable furnace.
Portfolio-stand.
Potato-masher.
Potato-washer.
Press.
Pressing-board.
Preserve-jar.
Quilting-frame.
Raisin-seeder.
Refrigerator.
Rimmer. Pie
Roasting-jack.
Rolling-pin.
Sabotiere.
Sad-iron.
Sad-iron heater.
Safe. Meat
Sausage-machine.
Sausage-stuffer.
Scoop.
Scrubbing-brush.
Scrubbing-machine.
Scuttle. Settee.
Sewing-box.
Shaving-cup.
Sieve. Sifter.
Skillet.
Skimmer. Slicer.
Smoothing-iron.
Smoothing-stone.
Snuffers. Sofa.
Spittoon. Spoon.
Steak-crusher.
Steam-cooking apparatus.
Steamer.
Step-ladder.
Stool.
Stoves and heating appliances (which see).
Table.
Toaster. Tongs.
Tray.
Tumbler-washer. Urn.
Vegetable-chopper.
Vegetable-cutter.
Vegetable-grater.
Vegetable-slicer.
Vegetable-washer.
Waffle-irons.
Waiter.
Warming-pan.
Wine-cooler.

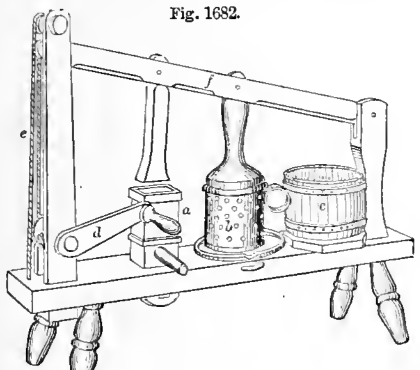
Washboard.
Wash-boiler.
Washing-machine.
Washing-shield.
Water-cooler.
Wire mattress.
Work-basket.
Wringer.

Do-mes'tic Boil'er. One for heating water on a somewhat large scale for the household. Such are made of sheet-metal, to set upon the top of a stove occupying two of the stove-holes; or, made of cast-iron, they form reservoirs as a permanent attachment to the stove. See WASH-BOILER; RESERVOIR-STOVE.

Dioscorides mentions tinned boilers. Pliny also treats of tinning copper vessels. Boilers with faucets have been disinterred at Herculaneum.

Do-mes'tic Press. One for household use for pressing honey, lard, tallow, cheese, sausage, or fruit.

Fig. 1682.



Domestic Press.

The press shown in the example has a sausage-stuffer *a* farthest from the pivoted end of the lever *f*. A lard-presser next, with a perforated tin hoop *b*. On the bench is also shown a platform and hoop *c* for fruit, which is substituted for the lard-hoop when required. *d* is a crank which operates the tackle and depresses the lever *f*.

Dom'ett. (*Fabric.*) A plain cloth, with cotton chain and woolen weft.

Do'ney. (*Nautical.*) A one-masted native vessel on the Coromandel coast, 70 feet long, 20 feet beam, and 12 feet hold.

Don'key-en'gine. (*Steam-engine.*) An auxiliary engine for working the feed-pump, hoisting in freight, etc.,— work unconnected with the propelling engines, and which may thus proceed when the main engines are stopped.

Don'key-pump. A steam-pump for feeding steam-engine boilers; frequently used for pumping in water during the cessation from working of the principal engine. It is used as a substitute for the feed-pump portion of the large engine; also used in breweries, distilleries, gas-works, tanneries, chemical works. One of the pumps is shown mounted on legs, another adapted to be bolted to a post or wall.

Doo'dle-sack. (*Music.*) The *bagpipe* (Ger. *dudelsack*).

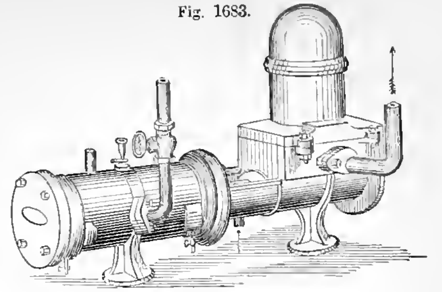
Dook. A wooden plug or block inserted in a brick or stone wall for the subsequent attachment of the finishing pieces.

Door. 1. An opening in a wall for a passage-way.

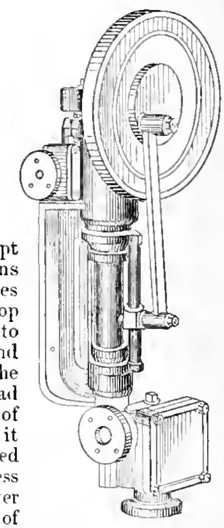
2. A frame or barrier closing said opening.

The word forms a part of many compound words, such as —

Fig. 1683.



Door-alarm.
Door-bell.
Door-case.
Door-fastener.
Door-knob.
Door-lock.
Door-nail.
Door-plate.
Door-spring.
Door-stone.
Door-stop.
Door-strip.
Door-way plane, etc.



Donkey-Pumps.

The doors of ancient Egypt and contemporary nations swung upon vertical pintles which projected from the top and bottom of the door into sockets in the lintel and threshold respectively. The commonest form of door had the pintle in the middle of the width, so that, as it opened, a way was afforded on each side of it for ingress or egress. This is much better than the villianous system of making the doors of churches, theaters, and assembly-rooms open inward, forming traps to catch the people when a stampede occurs from a fire or an alarm. It is but recent in our recollection, the account of the burning of a cathedral at Callao or some other city on the South American coast, when the building, decked out with paper and calico, in all the frippery of a saint's gala-day, was burned, with 800 miserable people,— women and children chiefly, for such are the principal patrons of churches in that land of Mestizoes.

It is not to be inferred that a simple valve swinging on a central axis was the only form of door, for in other structures we find the sockets near the posts, showing that the door turned upon an axis in the line of one of its vertical edges. Such doors, among the Romans, were fastened by bars or chains. Door-locks were known in Thebes centuries previous to the Augustan era of Rome, and some are to be found in the museums of Europe. See LOCK.

The street doors of Greek and Roman houses opened outward when formed of a single leaf, and an issuing citizen rang a bell to warn passengers in the street; or sometimes of a pair of leaves, each swinging on its own pintle and forming a double door. When doors were made to fold, they were swung inward; in this case one valve was hinged to another and swung back against its principal, the latter having pivots which turned in the threshold and lintel. Such doors were known in ancient Greece.

The doors of the residence of the Inca Huayna

Capac, in the vicinity of Cotopaxi, were similar to those of the Egyptian temples.

The doors of the oracle of Solomon's Temple were of olive-tree, and were "a fifth part of the wall." As the width of the house was 20 cubits, the doorway was about 6⅔ feet wide. The door was double. The outer door of the temple was of fir, and hung upon olive-tree posts. The doorway was about eight feet wide, and the double doors had each two leaves.

"The two leaves of the one door were folding, and the two leaves of the other door were folding."

It is not easy to find in any other very ancient author so clear a description of the proportions and construction of a building as is found in 1 Kings, vi.

A pair of doors have figured somewhat largely in the history of East Indian conquest. It is seldom that so much fuss has been made about a pair of doors since Samson took those of Gaza from their hinges, about 1120 B. C., and carried them to the top of a hill before Hebron. He took them "bar and all," not condescending to unlock them, but tearing them from their foundations.

The doors of the Temple of Siva, at Somnauth, a town of Guzerat, in Hindostan, were of sandal-wood, elaborately carved in correspondence with the other portions of the temple, which was an oblong hall 96 × 68 feet, crowned by a dome. When Mahmoud, of Ghizni, at the head of his Mohammedan hordes, invaded India (A. D. 1004), on a mixed mission of plunder and conversion, he mingled avarice with enthusiasm and lust, so as to afford a first-rate model for a demon to master Anacreon Moore, some 800 years afterward: —

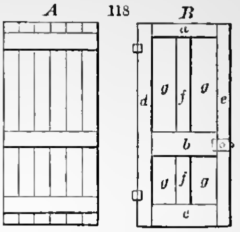
"'T is he of Ghizni, fierce in wrath
He comes, and India's diadems
Lie scattered in his ruinous path;
His bloodhounds he adorns with gems
Torn from the violated necks
Of many a young and loved sultana;
Maidens within their pure zenana,
Priests in the very fane he slaughters,
And chokes up with the glittering wrecks
Of golden shrines the sacred waters"

of the Ganges, of course. It must not be understood, however, that he failed to strip off the gold before he pitched these things into the muddy waters of the river, which delivers yearly into the Bay of Bengal 534,600,000 tons of solid matter.

Mahmoud, about 1024, after desolating Northern India for some years, came to Somnauth, and — omitting the details — plundered from the Temple of Siva "the destroyer" the rich offerings of centuries, carrying them and the doors of the temple to Afghanistan, where the latter were made the doors of his tomb.

Here they rested till 1842, when the English, stung to madness by the massacre of 26,000 soldiers and camp followers in the Kyber pass, in the month of January of the same year, invaded Afghanistan in force, and conquered Akbar Khan. Lord Ellenborough, inflated with an august desire for poetical, historical, and every other kind of retribution, seized upon the doors of Mahmoud's tomb as representatives of the success of Mohammedan domination, and carried them back to India proper, chanting a pæan whose refrain was "*the insult of eight hundred years is avenged*," and commanding that the doors should be "transmitted with all honor" to the Temple of Siva. The British government, goaded on the one hand by Exeter Hall, and on the other by its fear of the two unmingled races who occupy Hindostan, found itself with an elephant on its hands, and stopped the gates at Agra, where they remain.

Fig. 1684.



Doors.

A, *batten*-door.
B, *panel*-door.
a, top-rail.
b, middle or lock rail.
c, bottom-rail.
d, hanging style.
e, lock style.
f, munnion or muntin.
g, panels.

In a six-panel door the rail next to the top rail is called the *frieze-rail.*

A panel wider than its hight is a *lying-panel.* If of equal hight and width, a *square panel.* If its hight be greater than its width, a *standing panel.*

Double-door; two pairs of folding-doors, hung on the angles of the apertures and opening toward the reveals against which they are hung.

Folding-doors; a pair whose respective leaves are hung on opposite corners of the aperture in the same plane, so that the styles meet in the center when closed.

Double-margin doors are made in imitation of *folding*-doors, the middle style being made double with an intervening bead.

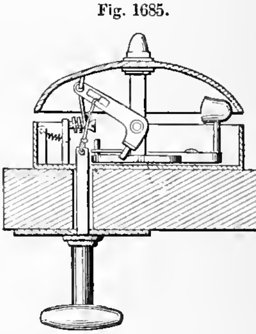
Sliding-doors are an improvement on folding; they slip into grooves in the partition.

A *proper-ledged* door is one made of boards placed side by side with battens called *ledges* at the back. With a diagonal piece at the back, in addition, it is said to be *framed and ledged.*

Door-a-larm′. A device attached to a door, to give an audible notice when the door is opened or tampered with. See BURGLAR-ALARM.

Door-bell. A bell attached to a door or door-post, or hung by a handle exposed outside of the door. In the example (Fig. 1685), the end of the lever, attached by a wire to the bell-pull, strikes a spur on the cam, one end of which, as it turns, forces down a bar attached by a bent wire to the hammer, till, the spur being released, the rebound causes the gong to be struck.

Fig. 1685.


Door-Gong.

In other instances, the bell or gong is sounded by the simple *turning* of the handle.

Door-case. The frame of a door, in which it swings and fits.

Door-fast′en-er. A portable contrivance for fastening a door. It usually consists of a piece jammed in between the door and the casing, having spurs which catch in the latter and a turn-button which engages against the door. In one example shown, it is a toggle-strut which thrusts against the door and the floor.

Door-frame. (*Carpentry.*) *a.* The structure in which the panels are fitted. It is composed of: —

The stiles, or upright pieces at the sides.

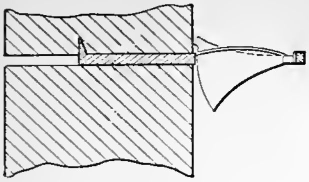
The munnions, or central upright pieces.

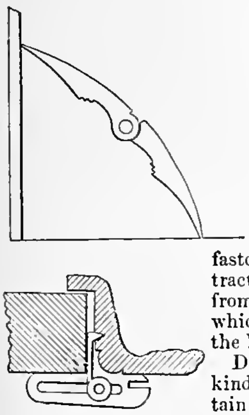
The bottom rail, the lock or central rail, and the top-rail. See DOOR.

b. The case into which a door is fitted.

Door′i-ahs. (*Fabric.*) A cotton cloth made in India.

Fig. 1686.





Door-Fasteners.

Door-knob. The bulb or handle on the spindle of a door-lock. It is made of metal, glass, porcelain, or clay of various colors. Ingenuity is employed in devising means of attaching the knob to its shank, and the latter to the spindle. With glass knobs, the shank of thin iron may be passed into the congealing glass in the mold. With clay and porcelain the heat of baking is too great, and the shanks are fastened to the knobs by cement or fusible metal.

Door-lock. A door-fastening whose bolt is retracted by a key; differing from a latch or catch, in which the bolt is worked by the knob or handle.

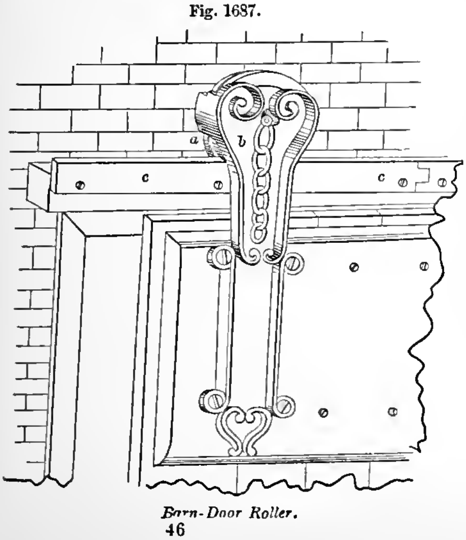
Door-locks are of various kinds, known usually by certain characteristic features of construction, sometimes from their purpose: —

Alarm-lock.	Janus-faced lock.
Box-lock.	Lever-lock.
Car-door lock.	Mortise-lock.
Cell-lock.	Permutation-lock.
Closet-lock.	Reversible lock.
Cross-bolt lock.	Rim-lock.
Dead-lock.	Safe-lock.
Front-door lock.	Sliding-door lock.
Jail-lock (see LOCK).	

Door-mat. A texture for wiping the feet; made of tussocks of hemp, flax, or jute woven or tied into a fabric; also made of sedge, straw, rushes, or other common material.

Door-nail. The plug (or plate) on which a door-knocker strikes.

Fig. 1687.



Barn-Door Roller.

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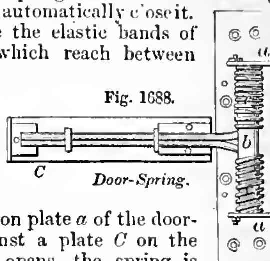
Door-plate. A name-plate on a door.

Door-roll'er. A suspension device for a sliding door. The roller *a* of the door-hanger *b* runs on a track plate or rod *c*. Used for doors of barns, warehouses, freight-cars, etc.

Door-spring. A spring attached to or bearing against a door, so as to automatically close it.

Of this nature are the elastic bands of vulcanized rubber, which reach between the top of the door and the lintel, being extended by the opening of the door, and, by contraction, closing it. In another form, a coiled spring is attached to a rod *b* on plate *a* of the door-post, and bears against a plate *C* on the door. As the door opens, the spring is coiled more tightly on its rod, and thus opposes a force which shuts the door when the person has passed. Another form is a torsion-spring; a wire whose ends are attached to the door and jamb so as to be twisted by the opening of the door.

Fig. 1688.



Door-Spring.

Door-stone. A threshold stone.

Door-stop. (*Carpentry.*) A knob or block on a skirting-board or floor, against which the door shuts. The object is to hold the door open or to catch it when opened clear back, and prevent the door-knob from bruising the wall.

Also a pad or strip on a door-case, against which the door shuts, to prevent slamming.

Door-strip. A strip attached near the lower edge of a door, to shut down tightly upon the threshold beneath when the door is closed. See WEATHER-STRIP.

Door'way-plane. The space included between the intrados of a large archway and the actual door of entrance.

Dop; Dopp. The copper cup in which a diamond is soldered when it is to be polished upon an iron *lap* or skive charged with diamond-powder. See DIAMOND-CUTTING.

Dor'mant-bolt. A concealed bolt working in a mortise in a door, and usually operated by a key, sometimes by a turning knob.

Dor'mant-lock. A lock having a bolt that will not close of itself.

Dor'man-tree. A large beam lying across the ceiling of a room, and serving as a joist. A *dormond* or *dormant-tree.*

Dor'mer-win'dow. (*Building.*) A window piercing a sloping roof, and having a vertical frame and gable of its own. The gable is sometimes in the plane of the wall, or is founded upon the rafters, sometimes a succession of stories in the roof are provided with dormers, as is commonly the case in some houses of Northern France, Belgium, and the Netherlands.

Dor'nock; Dor'nic. (*Fabric.*) A stout figured linen (*damask*), said to be named after the town in Scotland (Dornock) where it was made, but probably deriving its name from Tournay (Flemish, *doornic*), a frontier town of Belgium.

Dor'sel. (From Latin *dorsum*, the back.) 1. A pannier or basket to carry on the back.

2. *a.* A cover for a chair-back; hence,

b. Tapestry, or a screen at the back of a throne or altar.

c. Tapestry or wall hangings around the sides of the chancel of a church.

d. A canopy for a throne. A *lambrequin.*

3. A kind of cloth, used for the purposes stated.

Dor'sour. (*Fabric.*) Scotch cloth, used for hanging on walls of chapels and halls.

Do'ry. (*Nautical.*) A small, sharp, flat-bottomed boat, with very sloping sides, extensively employed in the British fisheries.

Dos'el. See DORSEL.

Dos'sil. (*Surgical.*) A small roll or pledget of lint of a cylindrical or ovoid form, to keep open a wound. A *tent*.

(*Printing.*) A roll of cloth for wiping off the face of a copper-plate, leaving the ink in the engraved lines.

Dotch'in. The Chinese steelyard. In Hong Kong, and other ports where Europeans trade, the beams are doubly graduated with circles of brass pins to mark British and Chinese weights.

Fig 1689.

Dotting-Pen.

Dots. (*Plastering.*) Nails driven into a wall to a certain depth, so that their protruding heads form a gage of depth in laying on a coat of plaster.

Dot'ting. A form of engraving in which geographical divisions on maps are shown by interrupted lines or series of dots. Done by a *roulette.*

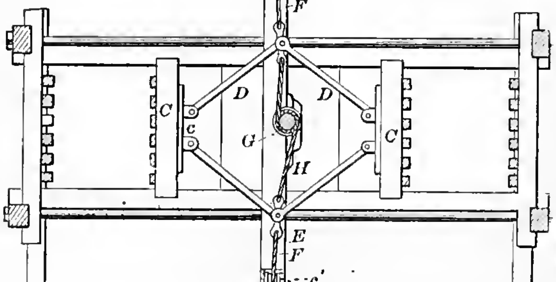
Dot'ting-pen. A pen having a roulette which makes dots or detached marks on the paper over which it is drawn. See ROULETTE.

Doub'le-act'ing Bal'ing-press. One which has two boxes in which the material is compressed ; sometimes a single follower acts upon them alternately, in other cases two followers act simultaneously.

In the first example shown, the press is double-ended, each follower forming an abutment for the other as they are forced together by the toggle-levers. The toggle-levers *D* are suspended upon the cords or chains *F H*, forming flexible suspension-points, whereby bales of unequal size are pressed with equal force by the platens *C*. The view is a plan, seen from above. The rope winds upon the central post *G* to which the power is applied, and it thence passes over the sheaves *c c* on the ends of the cross-beam.

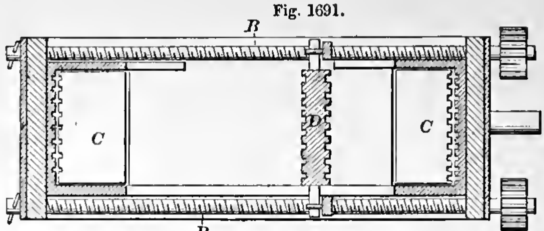
In Fig. 1691, a single follower *D* is used for two

Fig. 1690.



Double-Toggle Baling-Press.

Fig. 1691.

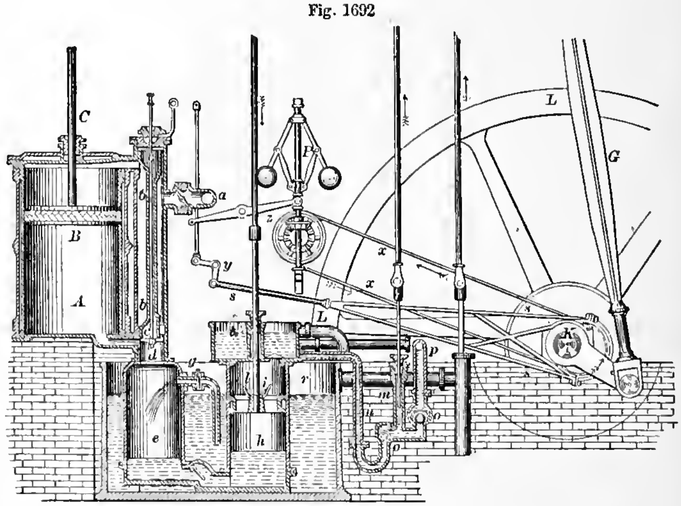


Screw Baling-Press.

press-boxes *C C* alternately, and is operated by four screws *B B* simultaneously driven, one at each corner, two showing in the illustration, which is a side elevation.

Doub'le-act'ing En'gine. (*Steam-engine.*) An engine in which both motions of the piston are produced by the action of live steam, which bears upon

Fig. 1692



Double-Acting Engine.

the faces alternately. In contradistinction to *single-acting*, in which live steam is only admitted to one side of the piston, the weight of a pump-rod or the pressure of the atmosphere giving the return motion.

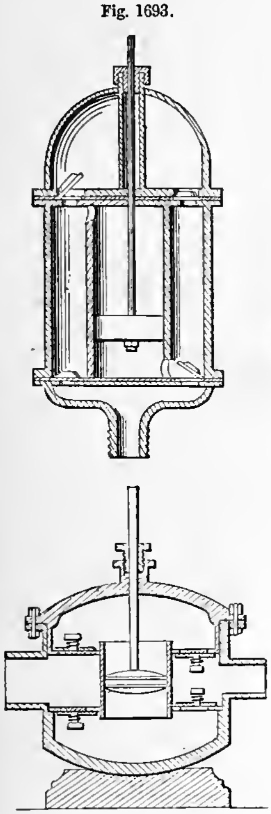
This form of engine was invented by Watt. The piston of the Newcomen atmospheric-engine, on which Watt was improving, was raised by steam at a moderate pressure, and depressed by the pressure of the atmosphere when the steam beneath the piston was condensed by a water-jet. Watt added the *separate condenser*, air-pump, and the steam-jacket to the cylinder, and then sought for means for keeping the atmosphere from the inside of the cylinder when the piston was depressed. He added the cylinder-cover, adopted the stuffing-box invented by Sir Samuel Morland, and admitted steam above the piston to occupy the space formerly filled with air. The steam retreated as the piston rose, and was afterwards utilized beneath the piston. Eventually the steam was regularly inducted above and below the piston alternately, in each case giving a positive pressure ; here we have the *double-acting engine.*

A, cylinder.	*C*, piston-rod.
B, piston.	*G*, pitman.

K, main-shaft.
L, fly-wheel.
P, governor.
a, steam-induction pipe.
b, valve-chamber.
c, valves.
d, steam-eduction pipe.
e, condenser.
g, injection-cock.
h, air-pump.
i, discharge-valve.
l, hot-well.
m, feed-pump.
n, pipe to feed-pump.
o, valves to feed-pump.
p, feed-pipe to boiler.
r, air-pump cistern.
s, eccentric-rod.
x, band to governor.
y, bell-crank to valve-motion.
z, governor-gearing.

Doub'le-act'ing Pump. One which throws water at each stroke; contradistinguished from the ordinary lift-pump, in which the bucket only raises water at the up-stroke.

Fig. 1693.



Double-Acting Pumps.

In the upper pump (Fig. 1693), the side chambers have each of them induction and eduction valves.

In the lower pump (Fig. 1693), the cylinder has induction and eduction ports on opposite sides *E F*.

Doub'le-ac'tion. (*Music.*) In a pianoforte movement, an arrangement of a jointed upright piece at the back end of the key, used to lift the hammer instead of the stiff wire or lifter of the single-action. The piece is called a *hopper*, and engages in a notch on the under side of the hammer to lift it, but, escaping or hopping therefrom, allows the hammer to fall away immediately from the string.

Doub'le-bar'reled Gun. One having a pair of parallel barrels on the same stock; sometimes one is a rifle-barrel and the other a smooth-bore for shot. See FOWLING-PIECE; FIRE-ARM.

Doub'le-bass. (*Music.*) The largest and lowest bass instrument of the stringed instruments played with a bow. A *contrabasso*.

Doub'le-bead. (*Joinery.*) Two beads placed side by side and separated by a quirk. See MOLDING.

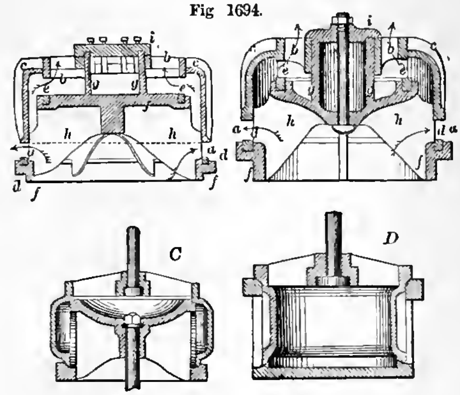
Doub'le-beat Valve. A valve so arranged that on opening it presents two outlets for the water, one at *a* and the other at *b*; in closing, the valve *c* drops upon the gun-metal rings *d c*, fixed in the seat *f*, which is of cast-iron; this is cast with a cylindrical portion *g*, which serves as guide to the valve, as do also the ribs *h h*. *i* is a cap which limits the throw of the valve.

The *double-beat valve* is extensively used in England for deep wells and for high lifts, such as the pumps of mines and water-works. It is so called from the fact that its lower edge *beats* upon a circular seat on the lower ring *d*, and a flange on its upper edge upon a *ring c*, on the upper plate of the valve-seat.

C is an external valve having inclined seats destitute of rings; *D* is an internal double-beat valve.

In the *double-beat* or *equilibrium* valve of the Cornish steam-engine, steam is conducted by a branch pipe into a larger perpendicular pipe between two conical valves placed in it and connected by a stem. When the valves rest on their seats, the steam will

Fig 1694.

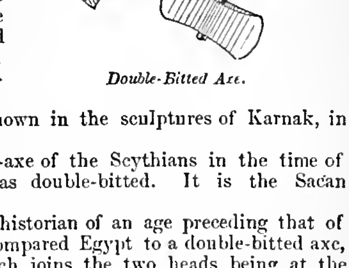


Double-Beat Valves.

exert a pressure on the under side of the upper valve, tending to raise it; and on the upper side of the lower one, tending to keep it down; these two pressures in opposite directions thus neutralizing each other. It is therefore evident that, the pressures being nearly balanced, but a small amount of power is necessary to raise the valves from their seats, and by a slight opening a very large steam-way is afforded.

Doub'le-bit'ted Axe. The axe has two opposite bits or blades. It is an ancient form of battle-axe, being a favorite weapon with the Franks in the time of Clotaire, seventh century, and with the Danes in the time of Alfred the Great, ninth century.

Fig 1695.



Double-Bitted Axe.

It is also shown in the sculptures of Karnak, in Egypt.

The battle-axe of the Scythians in the time of Herodotus was double-bitted. It is the Sacan *sagaris*.

Scylax, an historian of an age preceding that of Herodotus, compared Egypt to a double-bitted axe, the neck which joins the two heads being at the narrow part of the valley in the vicinity of Memphis.

The double-bitted axe is found in the tumuli and barrows of North America. It is in three forms: 1, with a circumferential groove for the occupation of the withe or split handle to which it is lashed; 2, with an eye traversing the head; 3, with a socket for the handle. See AXE; BATTLE-AXE; HATCHET.

Doub'le-block. (*Nautical.*) A block with two sheaves which are ordinarily placed on the same pin, but rotate in separate mortises in the shell.

Other double-blocks have the sheaves arranged one above the other. See LONG-TACKLE BLOCK; SHOE-BLOCK; FIDDLE-BLOCK; SISTER-BLOCK.

Doub'le-bod'ied Mi'cro-scope. A microscope invented by Nachet, to enable several observers to view the same object simultaneously. The rays from the objective are divided by a prism: the separated rays received by two other prisms, and the respective pencils directed through the respective bodies of the instrument. The principle is similar to that of the BINOCULAR MICROSCOPE (which see).

Doub'le-cap. A flat (unfolded) writing or book paper, 17 × 28 inches.

Fig. 1696.

Double-Chisel.

Doub'le-chis'el. A tool with two chisel-edges to cut the ends of a mortise simultaneously, while the chip extends into the depression between the bits. It is used in mortising sash-bars for windows.

Doub'le-cloth Loom. One for weaving two sets of webs simultaneously. These may be connected at certain parts, and cut apart subsequently, and so form a series of under-garments.

In another form, the two webs are so knitted as to form a tube, being joined at their edges. At certain intervals, both webs are thrown into one flat web of double thickness, and then again separated, forming a tube as before. The completed web is then cut apart mid-length of the doubled portion, and also mid-length of the tubular portion, and the result is a number of bags with closed bottoms.

Doub'le-com'pass. An instrument whose legs are prolonged each way beyond the joint, so that either pair may be used; when the legs on one pair are double the length of the others, it answers as a *bisecting-compass.*

Doub'le-con'cave Lens. A lens both of whose faces are concave. See LENS.

Doub'le-con'vex Lens. A lens both of whose sides are convex, though they may differ in the radii of their curves. When the difference is as 6 to 1, it is a *crossed lens.* See LENS.

Doub'le-cut File. One which has *two* rows of teeth, crossing each other at an angle, in contradistinction to the *single-cut* or *float*, which has but one row.

Doub'le-cyl'in-der Press. (*Printing.*) A press with one form, and receiving paper from two cylinders.

Doub'le-cyl'in-der Print'ing-ma-chine'. A printing-press in which the form is placed on a flat bed and the impression taken by two cylinders, each of which alternately takes a sheet and receives an impression from the form while it is passing under them.

Doub'le-cyl'in-der Pump. One having two cylinders in which the pistons act alternately. They may be single-acting or double-acting, that is, the cylinder may receive and deliver water at and from each end. The pumps of Hero of Alexandria, 150 B. C., were all single-acting, but one of them at least had a double cylinder.

Dou'ble-cyl'in-der Steam-en'gine. A form of engine having two communicating cylinders of varying capacities; there are many modifications in the arrangements and modes of application of the steam.

The first engine of this character was that of Hornblower, in which two piston-rods were connected to the same arm of the walking-beam, but at different distances from its center of oscillation. As usually understood, the double-cylinder engine involves the use of the same steam in two cylinders consecutively; first at a relatively high pressure in a smaller cylinder, and then at a lower pressure in a larger cylinder.

Working steam expansively was invented by Watt and introduced in 1778.

Hornblower's expansive engine, patented in 1781, had two cylinders, of different sizes, their respective piston-rods being connected to the working-beam. An amount of steam of the capacity of the smaller cylinder was expended at each stroke, the upper part of the said cylinder receiving live steam from the boiler, and the lower part communicating with the space above the piston of the larger cylinder, where it was used expansively.

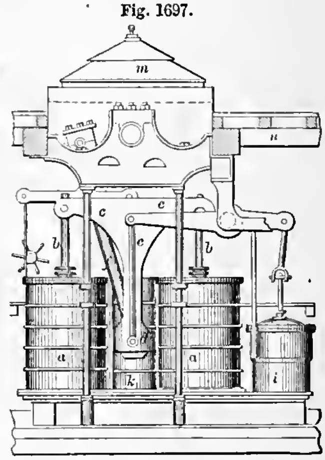
Hornblower's engine occupies one notable point in the history of the steam-engine, but was not adopted to any great extent.

Wolf, in his English patent of 1804, improved the arrangement, and his may be considered the progenitor of the numerous *compound* and *duplex* steam-engines which have proved so successful. See also Tippett's English patent, 1828.

This form of engine is extensively used in France, and the monster pumping-engines, with 144-inch cylinders, erected for draining the Haarlem Mere, from the designs of Gibbs and Dean, have double cylinders, one within the other, the outer being fitted with an annular piston. See DRAINING-ENGINE.

Maudslay and Field's double-cylinder steam-engine (English) is a form of engine having two cylinders, each of half the area necessary for the intended power, combined so as to form one engine, and placed so far apart as to leave a space between them for the connecting-rod, and the lower end of the T-shaped cross-head, to which the connecting-rod is attached. The piston-rods are attached to the horizontal extremities of the T cross-head, whereby the combined action of both pistons is applied to one crank of the paddle-shaft.

Fig. 1697.



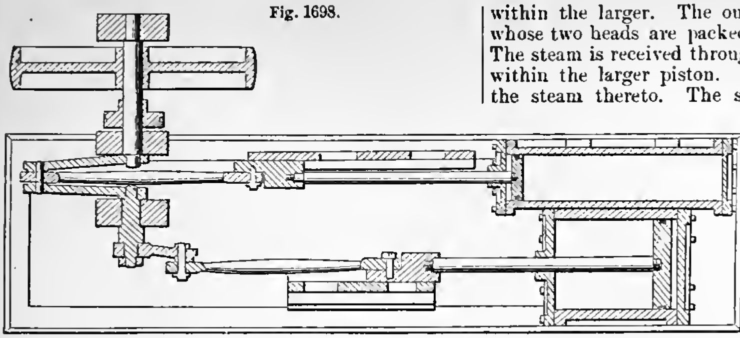
Maudslay and Field's Double-Cylinder Steam-Engine.

In the illustration, *a a* are the two connected working-cylinders, worked simultaneously by one slide-valve in the chamber *k*. *b b* are the piston-rods, the upper ends of which are attached by keys to the cross-head *c c c*. At the lower end of the cross-head is a slider *d* working between guides fixed on the outer surfaces of the cylinders. To this slider *d* one end of the connecting-rod *f* is attached, the other end of that rod being attached to the crank of the propeller-shaft. The air-pump *i*, feed-pump, and bilge-pump are worked by the lever, which is connected to the slider *d* by the rod. *m* is the skylight of the engine-room. *n* is a deck-beam.

This is one form of *direct-action steam-engine*, and was designed to obviate the use of a beam.

Fig. 1698 shows an arrangement in which two cranks on the same shaft and of different radii are

Fig. 1698.

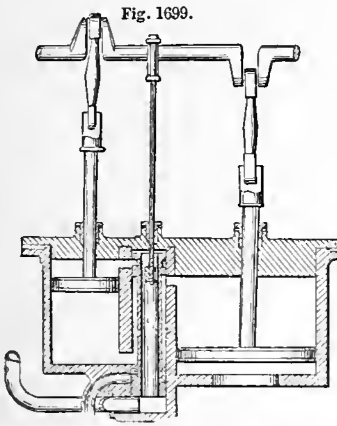


Huntoon's Engine.

respectively attached to pistons of varying diameter working in cylinders where the steam is used directly in one and afterwards expansively in the other.

In Fig. 1699, the cylinders are alongside each other. The rods of the pistons of the respective cylinders are united to the cranks, which have a relative angle of 180° on the same shaft. Steam admitted above the smaller piston is used directly, and, the valve being raised, is cut off; and the annular space between the two disks forms a means of conveying the steam below the said piston, where it is equalized as to its effect on that piston, and above the larger piston, where it is utilized expansively.

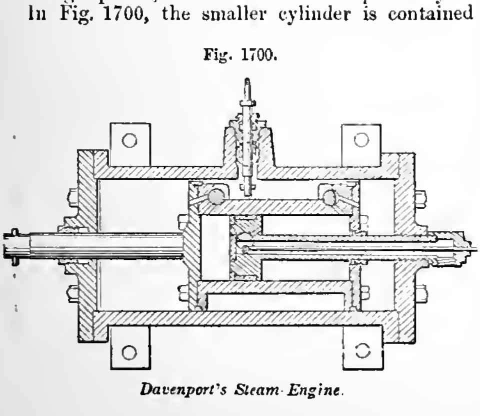
Fig. 1699.



Washburn's Steam-Engine.

In Fig. 1700, the smaller cylinder is contained within the larger. The outer piston is a cylinder whose two heads are packed in the main cylinder. The steam is received through a hollow fixed piston within the larger piston. An axial pipe conducts the steam thereto. The steam first acts on the inner side of the outer piston-head, and exhausts to act expansively on the outer end of the outer piston. It then passes through the annular space between the side of the outer piston and the main cylinder to the exhaust-ports.

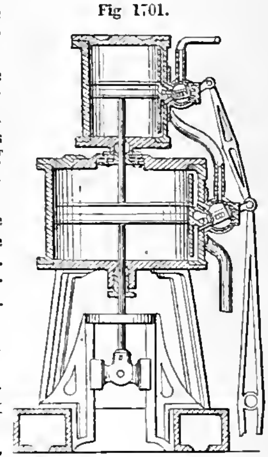
Fig. 1700.



Davenport's Steam-Engine.

In another form the steam, after acting at a high pressure against the piston in the upper cylinder, is allowed to escape to work against the larger piston at a less relative pressure per square inch. The valves are connected so as to time the movements, and the steam acts alternately *above* both pistons and then *below* both pistons to combine the effects of the steam in the respective cylinders.

Fig 1701.



Pease's Steam-Engine.

In Ellis's bisulphide of carbon engine, the heat of the exhaust-steam from one cylinder is made to boil the bisulphide of carbon, whose vapor is used in the second cylinder. See also COMPOUND-ENGINE; DUPLEX STEAM-ENGINE, etc.

Doub'le-dag'ger. (*Printing.*) A reference-mark (‡) next to the dagger (†) in order. Otherwise called a *diesis*.

Doub'le-door. Two pairs of folding-doors, hung upon the angles of the aperture and each swinging inward so as to open against the reveal. The inner pair is frequently covered with baize.

Dou'ble-d'or. A French style of jewelry; a plate of gold is soldered upon one of copper, the respective thicknesses being 1 and 11; the plate is then thinned by rolling, and worked up into the required form.

Doub'le-drill. A drill with two cutters, making a countersunk hole, so that the head of the screw or rivet placed therein shall not protrude.

Doub'le-draw'ing Pen. A draftsman's pen to rule two lines at once.

Doub'le-drum. (*Music.*) A large drum beaten at both ends. In contradistinction to other drums in which but one head is beaten; as, *side*, *snare*, and *kettle* drums. See DRUM.

Doub'le-el'e-phant. A size of drawing or flat writing-paper, measuring 26 × 40 inches.

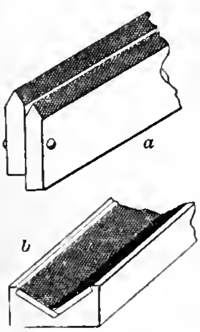
Doub'le-end'ed Bolt. A bolt having a screw-thread on each end for receiving a nut. It is used for binding together three parts or pieces independently of each other. (See 5, Fig. 768.)

Doub'le-ex-pan'sion Steam-en'gine. A form of engine in which steam, admitted to act upon a piston of relatively small area and cut off at a certain part of the stroke, so as to work expansively from that point to the end of the stroke, is then admitted to the face of a larger piston, where it undergoes a farther expansion. Such is the Allen engine (English), which has a large trunk-piston having two annular steam-spaces between the trunk and cylinder, affording two annular pistons of relatively small area; the ends of the trunk, which are of larger area, constituting two other piston-heads to receive the force of the steam at the second expansion. See also DOUBLE-CYLINDER STEAM-ENGINE.

Doub′le-faced. (*Joinery.*) A term applied to an architrave, or the like, having two faces.

Doub′le-file. A compound file (*a*) made of two files riveted together, one edge projecting beyond that of the other. Used by cutlers and gun-makers in checkering their work, as on the *small* of the gun-stock.

Fig. 1702.



Double-Files.

Cooper's double-file (*b*) is used for sharpening pencils, etc.

Doub′le-flu′id Bat′ter-y. A galvanic battery in which two fluids are used as exciting liquids. They are kept apart by a porous cup, as in the Daniell's battery, or by gravity, as in Callaud's (see *infra*). Daniell was the inventor of this form of battery, and received therefor the "Copley" medal of the Royal Society in 1837. He used sulphuric acid in a porous cup placed in a glass cup containing sulphate of copper.

Bunsen's, Grove's, and Callaud's are also double-fluid batteries. The name is used in contradistinction to the *single-fluid* batteries, such as the original Volta, the Cruikshank, Babbington, and Wollaston.

The gravity-battery is a double-fluid battery in which the porous cup is dispensed with, the difference in the specific gravity of the fluids used keeping them separate. Often called the "Callaud battery," after the name of the inventor.

Doub′le-floor. (*Carpentry.*) One in which both binding and bridging joists are employed. A *double-framed* floor.

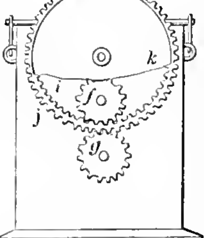
Doub′le-fur′row Plow. One striking two furrows at once. A *gang* or *double* plow.

Doub′le-fut′tocks. (*Shipbuilding.*) Timbers in the cant-bodies extending from the deadwood to the run of the second futtock-head.

Doub′le-gear. The nests of variable-speed gear-wheels in the head-stock of a lathe. *Back-gear.*

Doub′le Gear-wheel. A wheel which has two sets of cogs of varying diameter; these may drive two pinions, or be driven of one and drive the other. In the example, the wheel *j* drives the two pinions *f g*. The cover *k* is shown as partially broken away to expose the inner gear and the pinion *f*.

Fig. 1703.



Double Gear-Wheel.

Doub′le Half-round File. A file whose sides are curved, the edges forming cusps; the arcs of the sides being much less than 180°. Used for dressing or *crossing-out* balance-wheels, and hence known as a cross-file. The convex edges have usually different curvatures. See FILE.

Doub′le-ham′mer. (*Metallurgy.*) A forging device for operating upon a bloom or puddler's ball, striking it upon opposite sides simultaneously. See Grüner's "Manufacture of Steel," Van Nostrand, 1872; page 152 *et seq.*, and plates v, vi.

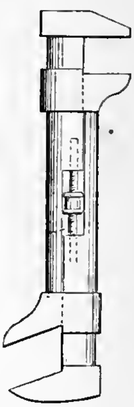
Doub′le-head′ed Rail. (*Railroading.*) A rail whose edges are bulbous and counterparts, so that when one is worn the other may be placed uppermost.

This rail does not rest so securely on the sleepers, having no flat base like the *foot-rail*, or *bridge-rail*, but requires a chair on each sleeper. This greatly increases the expense in fastening to the sleepers.

Doub′le-head′ed Shot. (*Ordnance.*) A projectile formerly used, consisting of two shot united at their bases.

Doub′le-head′ed Wrench. One having a pair of jaws at each end, one diagonal the other right-angular. The shank of each outer jaw is connected to the sleeved inner jaw of the other pair, the sleeves slipping on the shanks of the jaws to which they are opposed. The double threads act in conjunction, to expand or close each pair simultaneously.

Fig. 1704.


Double-Headed Wrench.

Doub′le-hung Win′dow. One with two sashes, each having its complement of lines, weights, and pulleys.

Doub′le-im′age Mi-crom′e-ter. Suggested by Roemer about 1678; brought into use by Bonguer about 1748. It is formed by dividing diametrically the object-glass of a telescope or microscope, the straight edges being ground smooth so that they may easily slide by one another. The parts are separable by a screw, which moves an index on a graduated scale. A double image of the object in the field of view is produced by the separation of the segments; and by bringing the opposite edges of the two images into contact, a measure of the diameter of the object is obtained in terms of the extent of the separation. A *heliometer*.

Doub′le-im-pe′ri-al. A size of printing-paper 32 × 44 inches.

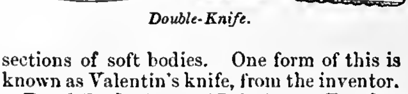
Doub′le-joint′ed Com′pass. One having, in addition to the main joint, additional joints by which legs may be bent to secure a proper presentation of the feet to the paper.

Fig. 1705.


Double-Jointed Compass.

Doub′le-knife. A knife having a pair of blades which may be set at any regulated distance from each other, so as to obtain thin sections of soft bodies. One form of this is known as Valentin's knife, from the inventor.

Fig. 1706.


Double-Knife.

Doub′le-let′ter. (*Printing.*) Two letters on one shank, as *ff*, *ffi*.

Doub′le-light. A variety of light as displayed for the warning and instruction of mariners from lighthouses. The light indicates land, rock, or shoal, and, by varying the characteristics of the light, the seaman is informed of the part of the coast he is on, and of his bearings as to his port or course.

The other characters of light are known as *fixed, revolving, intermittent, flashing, colored.* These are variously combined.

The double-light is usually exhibited from two towers. One of these is sometimes higher than the other. The duplication of the lights affords a leading line as a guide to a channel, as well as furnishing another mode of varying the lights on a coast where they are numerous. See LIGHT.

Doub'le-line. (*Harness.*) *a.* A form of driving-lines or reins in which supplementary reins are afforded, which may be brought into use in emergency, such as an attempt to bolt. In some cases it is an extra rein to pull the horses' heads together; a rein to pull a hood over the eyes of a horse; a gag-rein to pull the bit violently into the corners of his mouth; a choking-rein around the throat; a gripper on the muzzle; shutters on the nostrils, etc.

b. A description of driving reins or lines in which each main branch has a check-line to the bit of the other horse. Distinguished from the Western teamster's *single-line.*

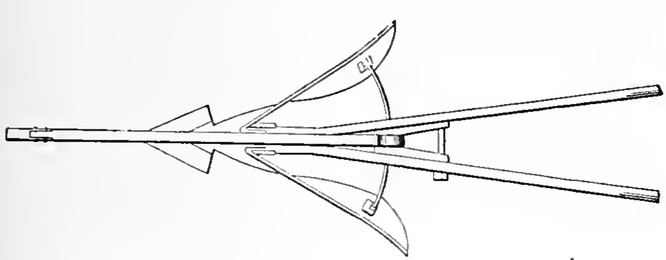
Doub'le-lock. A canal-lock having two parallel chambers connecting by a sluice. Each chamber has a gate at each end connecting with the upper and lower *pounds* respectively. The object is to save one half the water that would be used in *locking* boats.

Doub'le-mar'gin Door. (*Joinery.*) One framed in imitation of folding-doors, the central style being made double with an intervening bead.

Doub'le-me'di-um. A size of printing-paper 24 × 38 inches.

Doub'le-mold'board Plow. (*Agriculture.*) A plow having a moldboard on each side of the

Fig. 1707.



Double-Moldboard Plow.

sheth, so as to throw the soil away right and left. It is used in hilling up crops, such as potatoes and cabbages. Not used for corn; the rows are too wide apart.

A double-moldboard plow was used by the Romans in *ribbing* the ground for wheat. This left the ground in ridges whose summits were seeded by hand-drilling.

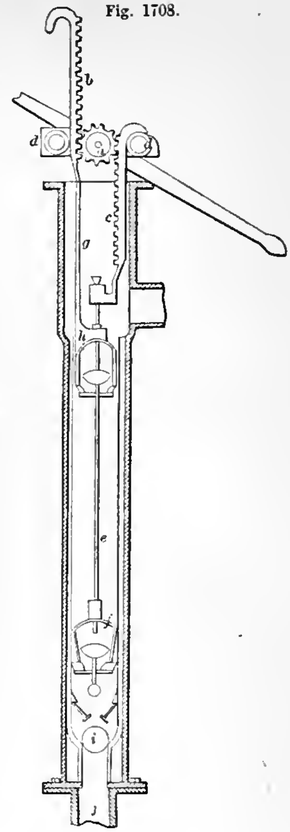
Doub'le Pi'ca. (*Printing.*) A size of type double the hight of Pica.

Double Pica.
Great Primer.
English.
Pica.
Small Pica.

Doub'le-piled Fab'ric-loom. One in which a pile is formed on both sides of the *foundation,* and which may be produced from either the warp or weft. See Crompton's patent, January 31, 1871.

Doub'le-pis'ton Pump. One which works two pistons from a single lever or handle. It may be double or single acting as to the separate pistons.

Fig. 1708.



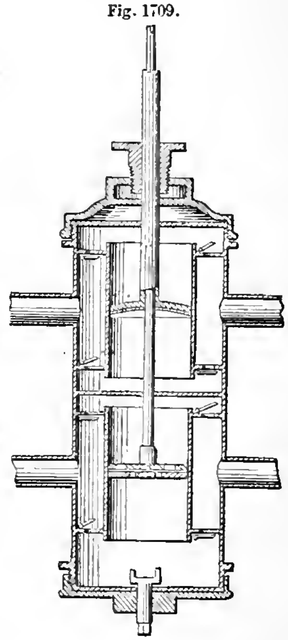
Double-Piston Pump.

In Fig. 1708 the pistons are effective alternately, each upon its up stroke. One bucket slides on the rod of the other. The lever gives reciprocating rotation to the pinion *a* which works the racks *b c,* which back against rollers *d d*; *g h* are the upper rod and bucket, *p* and *e f* the lower pair. *i* is the lower valve; *j* the induction-pipe.

Another form is shown in Fig. 1709, in which the pistons are fast on the same rod and reciprocate in their respective cylinders, which are divided by a diaphragm. The pumps are independent, therefore, except as the pipes may connect; and may be utilized for pumping fluids from two sources and delivering them together or separately.

Doub'le Pis'ton-rod En'gine. A direct-action steam-engine invented by Maudslay and Field, London, and designed for

Fig. 1709.



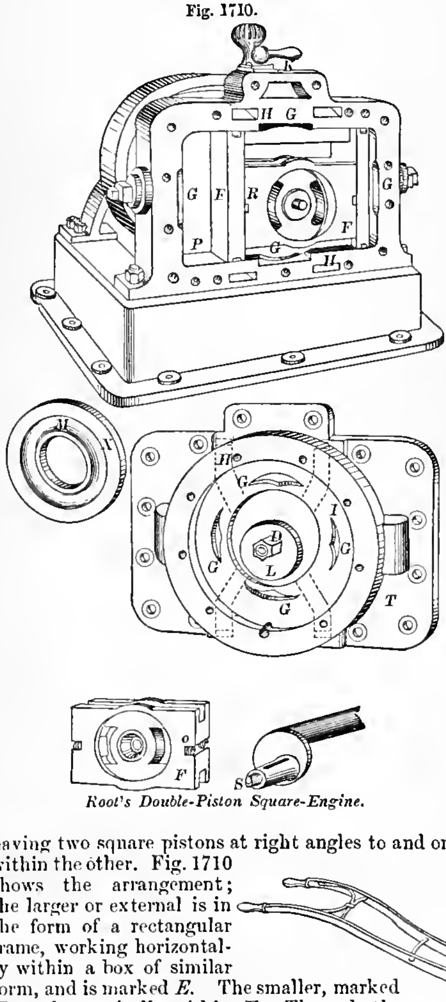
Double-Piston Pump.

vessels of low draft and shallow holds, without exposing the machinery above deck. It is one of the numerous attempts to avoid the use of a beam or side-lever. See DIRECT-ACTION STEAM-ENGINE.

The *double piston-rod engine* has two piston-rods to each piston, the center of the cylinder-cover is plain, and this allows the crank when lowest to barely clear the said cover, thus saving the depth of a stuffing-box. The two piston-rods issue from opposite apertures, but neither in the longitudinal nor transverse line of the ship. It is said to afford the shallowest arrangement yet known with no beam above deck, and is used on the Rhone, the Indus, and the Sutledj.

Doub'le-pis'ton Square-en'gine. An engine

Fig. 1710.



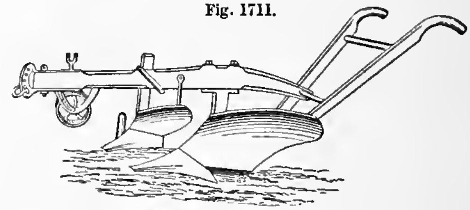
Root's Double-Piston Square-Engine.

having two square pistons at right angles to and one within the other. Fig. 1710 shows the arrangement; the larger or external is in the form of a rectangular frame, working horizontally within a box of similar form, and is marked *E*. The smaller, marked *F*, works vertically within *E*. Through the center of *F* passes the crank *D*, which is carried around by the simultaneous action of both pistons. The smaller piston *F* and crank *D* are shown separately. *T* is an outside view of the cover which closes the steam-box or cylinder, the circular chamber being the valve-box *I*, which is closed by another plate screwed over it. The steam is admitted at *K*, passes by a hidden passage to the valve-box *I*, and to the cylinder through openings *G*, whenever they are uncovered by the valve *X*. Through the same openings the exhaust-steam escapes, not into the valve-box, but into the annular channel *H* through the annular countersink *M*. The exhaust-steam escapes by passages indicated by dotted lines leading to the openings *H H*, and thence by passages to a common eduction-pipe. The valve-plate *X* is fitted to the eccentric *L* on the center-pin *D*, and this eccentric is carried around by a stud *S* in the end of the crank, which enters an arm on the other side of the plate, for which space is made in the central circular recess of the smaller piston. The valve is in contact by its circumference with the interior cylindrical surface of the valve-box, on which it rolls during its revolution, and it opens and closes the steam-ports successively as it passes.

Doub'le Plane-i'ron. (*Wood-working.*) A smoothing-plane iron having a *counter*-iron to bend up the shaving in working cross-grained stuff.

Doub'le-plow. 1. The double-plow, in which a shallow share preceded the deeper-running, longer plow, originated in England, where it is known as

Fig. 1711.



Michigan Double-Plow.

the *skim-colter plow*. This has a share attached to the colter to turn down the top soil with its weeds and trash, to be covered with the main furrow-slice, which is turned over by the larger plow following.

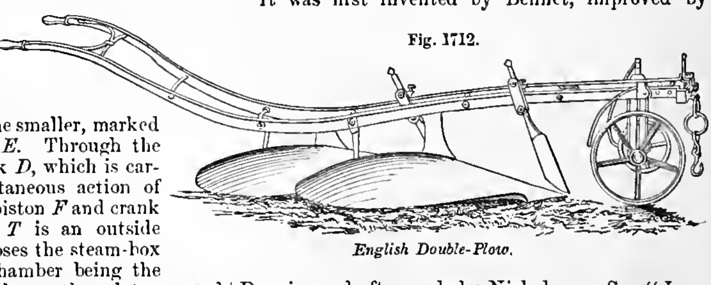
In England and in the United States another form of this plow has been used in which the precedent portion is not merely a flange on the colter, but is a regular moldboard plow of small proportions, higher than and in front of the main plow. This is known in Ohio as the "Michigan double-plow," and is an efficient implement requiring four horses.

2. The *double-plow*, having two plows to one stock, or two stocks framed together so as to have but one pair of handles and be operated by one man, is mentioned by Walter Blythe, who wrote during the protectorate of Oliver Cromwell. See GANG-PLOW.

Doub'ler. 1. (*Electricity.*) An instrument to increase the least conceivable quantity of electricity by continually doubling it, until it becomes perceptible upon a common electrometer or is made visible in sparks.

It was first invented by Bennet, improved by

Fig. 1712.



English Double-Plow.

Darwin, and afterwards by Nicholson. See "Journal of the Telegraph," Vol. VI., No. 1, December 2, 1872.

2. (*Distilling.*) A part of the still apparatus, or an appendage to a still in which the low wines, one of the products of the first distillation, are re-distilled. The operation is a turning back and repeating, and is known as *doubling*. A part of the still is arranged to condense and then intercept and return the less volatile vapors, while those of greater tenuity pass on.

3. (*Fiber.*) A machine in which slivers, stricks, or filaments of wool, cotton, flax, or silk are laid together, to be drawn out and again doubled and drawn to remove inequalities, or, in the case of silk, to increase the thickness of the strand. See DOUBLING.

4. (*Calico-printing.*) A blanket or felt placed between the cloth to be printed and the printing-table or cylinder.

Doub'le-re-frac'tion Mi-crom'e-ter. The Abbé Rochon first applied the principle of double refraction to micrometrical measurements. His instrument had two prisms connected together so as to form a single crystal. The prisms are so disposed that the face of the first is perpendicular to the axis of the crystal, while in the second the axis is parallel to the line of intersection of the two faces, so that the axes of crystallization of the two prisms are at right angles to each other. The prisms are placed in perfect contact and cemented by mastic, and together form a plate, the opposite sides of which are parallel.

As the ray enters the second prism the ordinary ray passes on, and the extraordinary ray is refracted. The angle of divergence of the rays is constant in the same prism, and is determined by experiment.

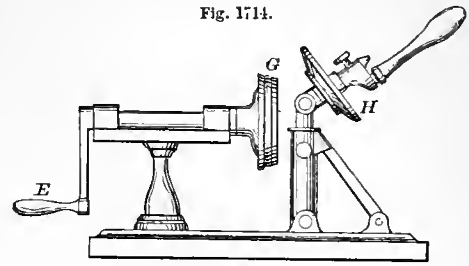
The apparatus is placed in the tube of a telescope, where it may be slipped back and forth. The determination of the diameter of the object is obtained by bringing the images in contact.

Doub'le-roy'al. A size of printing paper 26 × 40 inches.

Doub'le-saw. A stock having two blades at a regulated distance, adapted to cut kerfs and space the intervals, as in comb-cutting. See COMB.

Doub'le-seam'ing Ma-chine'. A tool or machine for lapping the edges of sheet-metal one over

Fig. 1714.

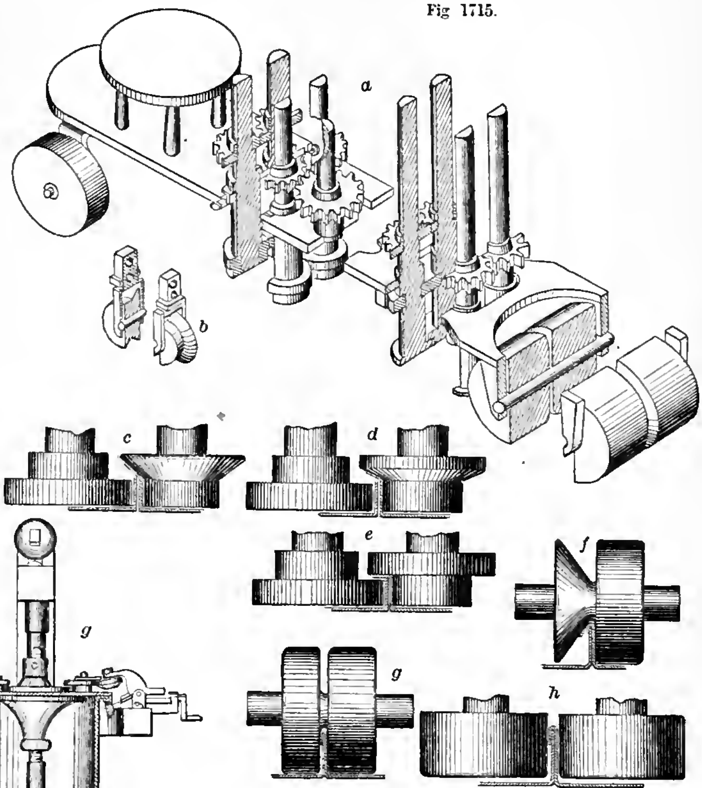


Double-Seamer

the other, and then doubling over the lapped portions so as to preclude the possibility of the portions slipping apart. The seaming process appears in Fig. 1713, where *a* represents a can top and lid simply laid together; *b* shows the two parts turned over; *c* shows the outer portion recurved over the inner one.

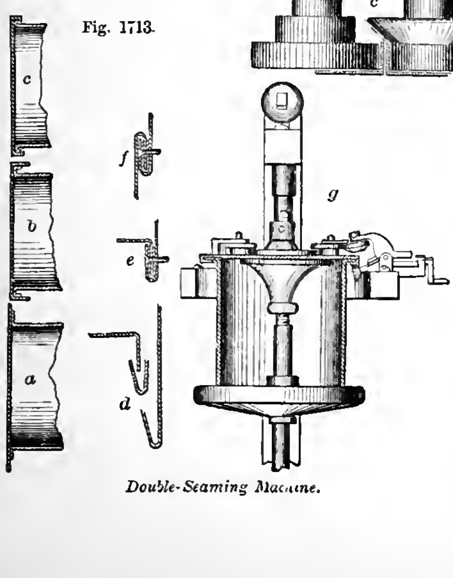
d, in the same figure, shows the parts of a seam

Fig 1715.



Roof-Seaming Machine.

Fig. 1713.



Double-Seaming Machine.

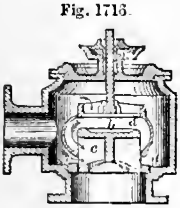
with an intervening strengthening strip; *e f* are two farther conditions of the same joint, with a rivet to secure the parts in position; *g* is a view of the machine on which the bending *a b c* is done by a succession of disks, cone-rollers, and clamping-rollers.

Fig. 1714 is another double-seaming machine in which the compressing disk *H* is journaled on top of the standard, and is brought into conjunction with the vertical disk *G* on which the pan or can rests, and is revolved by the crank *E*.

Double-seaming machines for roofing have a number of consecutive pairs of rollers which are run along the upturned edges of the adjacent sheets so as to lap one over the other, bend the two and press the folded-over part against the standing part. In Fig. 1715 *a* shows the machine in isometric projection, a series of transverse sections being made to show the different pairs of rollers in the succession. *b* shows one of the rollers detached and also sectioned to exhibit the structure. *c d e f g h* is a series of the pairs of rollers on an enlarged scale, and showing the successive shapes assumed by the edges of the tin plates.

Doub'le-seat Valve. Perhaps another name for the double-beat valve, and the more appropriate term of the two.

Fig. 1716.

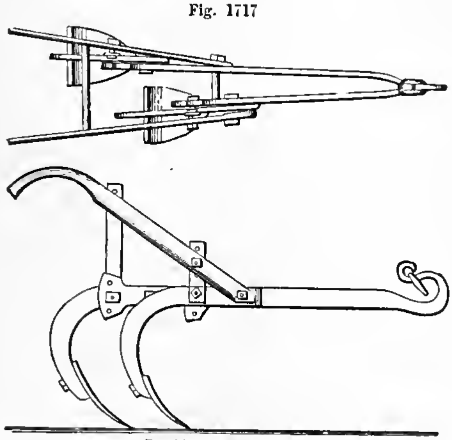


Double-Seat Valve.

The aperture *a* is beveled around to form the usual valve-seat. *c c* are two of five or six thin vertical plates radiating from the center and supporting the flat disk *b*, the edge of which is also beveled conically to form a second seat. The valve itself is a bulging cylinder *d*, open-ended, and shuts down upon both these seats. The effective pressure on the valve is only as the difference in the areas of the two seats. A bar across the top receives the valve-rod, which passes through a stuffing-box. The valve being opened, the steam enters at two ways, and a large effective opening is instantaneously afforded. See DOUBLE-BEAT VALVE.

Doub'le-shov'el Plow. A plow for tending crops, and having two small shovels on as many sheths. They are arranged a little distance apart,

Fig. 1717

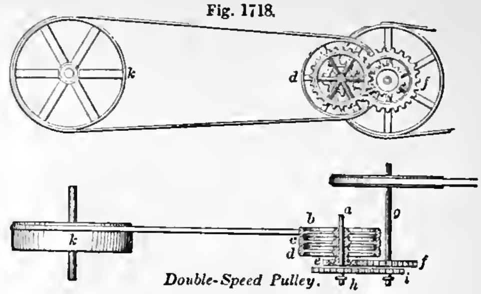


Double-Shovel Plow.

and one a little behind the other. The left-hand plow is a little in the rear when the right is specially engaged in working the crop.

Doub'le-speed Pul'ley. A contrivance for giving what is termed *double speed* to the spindles of the self-acting mule. On the spindle *a*, which receives the motion, are three drums, *b c d*; of these, *b* is fast on the spindle, *c* is loose, and *d* also loose, but connected with the pinion *e*, which works into the spur-wheel *f*, fixed on the spindle *g*, to

Fig. 1718.



Double-Speed Pulley.

which the motion is to be communicated. On the spindle *a* is fixed the spur-wheel *h*, which works into the pinion *i*, likewise fixed on the spindle *g*. When the belt from the driving drum *k* is on *b*, it communicates a fast motion to the spindle *g*; when on *c*, the machine is out of gear, and when on *d* it imparts a slow motion to *g*.

Doub'le Su'per-roy'al. A size of printing-paper 27 × 42 inches.

Doub'le Steam-en'gine. A steam-engine which has two cylinders acting coincidently or alternately. Two double-acting oscillating cylinders, acting upon a two-cranked shaft, work coincidently, and form a *double*-engine. Leopold's engine, about the middle of the last century, was a double-engine, a duplication of the Newcomen atmospheric-engine. It had two cylinders, each working its own pump, and operating alternately. The *double* steam-engine (Leopold's) preceded the double-acting (Watt's). See DOUBLE-CYLINDER STEAM-ENGINE; DUPLEX STEAM-ENGINE.

Doub'let. 1. (*Optics.*) An arrangement of lenses in pairs, invented by Wollaston. It consists of two plano-convex lenses having their focal lengths in the proportion of one to three, or nearly so, and placed at a distance determinable by experiment. Their curved sides are placed towards the eye, and the lens of shortest focal length towards the object.

It is a reversal of the Huyghenian eye-piece, and its object is similar, — to correct spherical aberration and chromatic dispersion. The *stop* placed between the lenses intercepts extreme rays that might mar the perfection of the image. An amplification of the idea is called a TRIPLET (which see). See also LENS.

Sir John Herschel's doublet consists of a double convex lens having the radii of curvature as one to six, and of a plano-concave lens whose focal length is to that of the convex lens as thirteen to five. It is intended for a simple microscope, to be used in the hand. See LENS.

2. A factitious gem made with a colorless front and a colored back, cemented together by clear mastic on the line of the girdle.

Doub'le-tang File. A file with a tang at each end, to adapt it to receive the handles.

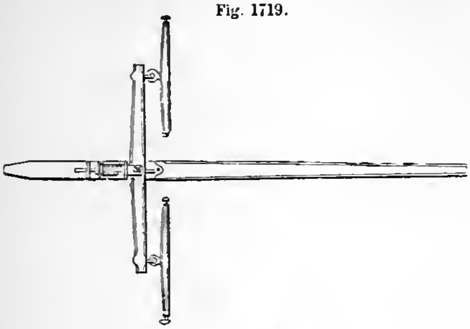
Doub'le-tree. The bar which is pivoted to the tongue of a carriage, wagon, or sled, or to the clevis of a plow or other implement. To the ends of the double-tree the single-trees are attached, and to the ends of the single-trees the traces are connected.

The double-tree varies in shape with the description of vehicle, but has such a length that its ends are immediately behind each horse, so that the traces of the animal may pull squarely upon them through the medium of the single-trees.

In wagons, the double-tree is attached to the tongue by means of a bolt called the *wagon-hammer*, upon which it swings as one or the other horse pulls the more strongly upon it.

Near the ends of the double-tree and behind it are loops for the *stay-chains*, which are connected to hooks in front of the fore-axle, so as to limit the sway of the double-tree.

Fig. 1719.



Double and Single Trees.

For plowing and similar duty, the double-tree is sometimes arranged with three clevises ; by the middle one it swings from the clevis of the plow or cultivator, and by the end clevises the *single-trees* are attached.

Doub'le Wa'ter-wheel. An arrangement of two water-wheels on one shaft, as in the case of a double-headed turbine, which has a wheel at each end of a horizontal shaft.

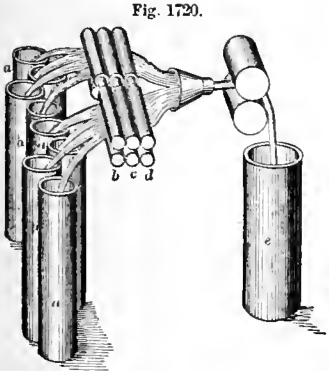
Doub'le-win'dow. One having two sets of sash, inclosing a body of air as a non-conductor of heat and to deaden noise.

Doub'ling. 1. The second distillation of *low wines.* These are the product of the first distillation, and contain about one fifth alcohol.

2. The double course of shingles or slates at the eave of a house.

3. (*Cotton or Wool.*) Bringing two or more *slivers* of fiber together and forming them into one of greater thickness, to be again reduced by drawing ; thus obtaining a sliver of uniform thickness.

Fig. 1720.



Doubling.

The slivers from the carding-machine, each in its separate can *a a*, are conducted between one pair of rollers *b*, which causes them to coalesce ; then through a second pair *c*, revolving at an increased speed, which draws out and lengthens the sliver, and then through a third pair *d*, which still attenuates the sliver. The operation is repeated as often as may be necessary to correct every inequality in the thickness of the sliver.

The next process is *roving*, which is also performed by *drawing-rollers ;* but as the sliver has become so reduced in thickness, it receives a slight twisting, to enable it to hold together. This was formerly obtained by giving a rapid revolution to the receiving-can *c*. See Roving ; Drawing.

4. (*Flax-manufacture.*) The process with flax is similar to that described as pertaining to cotton.

In the first place, the *stricks* or handfuls of hackled flax are spread on a traveling-apron and conducted to drawing-rollers, which bring the filaments to an attenuated sliver and deliver it into cans. The slivers from a number of cans, from six to fifteen usually, are then conducted to drawing-rollers, being thereby *doubled* and *drawn ;* the process is repeated, as with cotton, until the sliver is equalized and reduced to the required degree. See Drawing.

5. (*Silk-manufacture.*) The twisting together of two or more filaments of twisted silk. This process follows the first spinning of the filaments of silk, and precedes the *throwing*, which is a farther combining of threads and twisting them together. First, the twisted filaments ; then the *doubling*, forming *dumb-singles ;* then the *throwing*, forming *thrown-singles.*

The process of doubling silk differs from that of doubling cotton and flax, inasmuch as the silk filaments are continuous and cannot be *drawn.* The *doubling* of flax or cotton fibers is for the purpose of equalizing the thickness of slivers, and the *drawing* which accompanies each operation is for the purpose of lengthening the combined slivers so as to make an attenuated sliver. By this means any trifling irregularity in the thickness of a sliver is lost by causing it to coalesce with others and elongating the bunch ; the process being repeated again and again, as may be necessary.

In the doubling of silk, as there is no re-attenuation by drawing, the number of filaments are combined into one thread of the aggregate thickness of the several filaments.

The bobbins of thread to be doubled are mounted on a small frame, and the ends, being collected, are passed through a loop and attached to a bobbin, upon which they are wound. The parallel threads are then transferred to a horizontal reel, from whence each set of combined threads is carried through the eye of a rotating flyer and wound upon a bobbin, the combined threads or strands being twisted into a cord. The latter operation is known as *throwing.*

The direction of the twist is varied for different qualities and varieties of silk goods.

In ordinary spinning of the silk filaments the twist is to the right.

For *tram ;* the spinning of the filaments is omitted ; when *doubled*, the thread is twisted to the right.

For *organzine* the filament is twisted to the left, then *doubled* and twisted to the right.

The twisting of the thread is *set* or made permanent by exposure to steam.

6. (*Nautical.*) *a.* Of the bitts. A piece of fir timber fitted on the back of the cross-piece. *Fir-lining.*

b. Of a sail. The double-seamed border for receiving the bolt-rope. The edging or skirt.

7. (*Shipwrighting.*) Strakes of plank fastened on the outer skin of a ship ; used as a fender against floating ice.

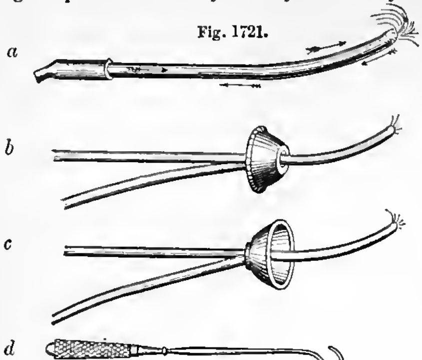
Doub'ling and Twist'ing Ma-chine'. One by which a number of slivers of fiber are associated, drawn out, and partially twisted ; or one in which strands are laid together and twisted into a thread or cord. See Doubling ; Drawing-frame.

Doub'ling-frame. (*Silk-manufacture.*) A winding-engine for double silk threads.

Doub'ling-nail. A nail used in securing sheathing, lining, or supplementary covering to an object ; such as the lining of gun-ports, etc.

Douche. (*Surgical.*) An instrument for injecting a liquid into a cavity. They are usually known

Fig. 1721.



Douches.

by the name of the part to which they are applicable.

a is a catheter douche for drenching the urethra, or reaching the interior of the bladder.

b is a douche for the vagina, having one tube for the water injected, and another for the efflux.

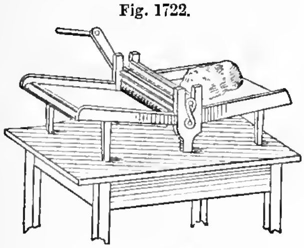
c is a uterine douche, with a cup to fit the cervix while the point enters the uterus.

d is a holder to be used with the vaginal or uterine douche.

Other douches are specially constructed for the nose, the posterior nares, the eye, ear, etc.

Dough-knead'er. A pair of rollers, one corrugated lengthwise and the other transversely, working in a frame with two inclined boards and a disk below the lower roller propelled by a crank, and the rollers geared together by elastic cross-bands. There are other forms, such as a roller swiveled to a post, like the brake of a cracker-maker, which is also a dough-kneader.

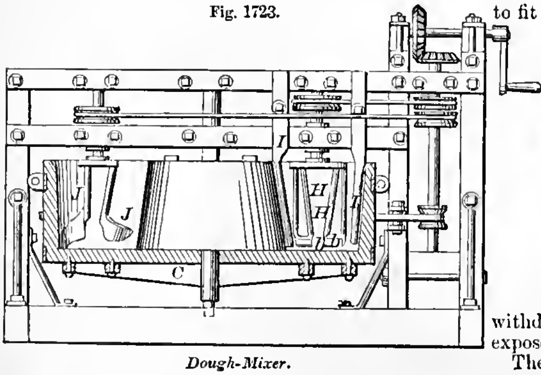
Fig. 1722.



Dough-Kneader.

Dough-mix'er. A kneading-machine consisting of a vessel having two pipes entering through its head and a discharge-pipe at the bottom. The flour is placed in the vessel, and the yeast and water,

Fig. 1723.



Dough-Mixer.

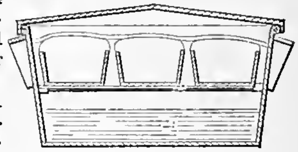
highly charged with carbonic acid and mixed with a proper quantity of salt, are passed into the vessel through one of the upper pipes, and the whole incorporated by the revolution of a vertical shaft with stirrers; when thoroughly mixed, the contents of the vessel are discharged through the pipe at the bottom. It is a kind of pug-mill.

In another form of machine, the rotating annular trough *C* has two pairs of rotating beaters *H H*, to which are attached scrapers *b* for its bottom, while the sides are cleared by stationary scrapers *I*, and on the shafts are rods having screw-blades *J J*, reaching nearly to the bottom, to raise up and knead the dough.

Dough-rais'er. A pan in a bath of heated water, to maintain a temperature in the dough favorable to fermentation.

Dough-trough. A baker's or household receptacle, in which dough is left to ferment. In Fig. 1724 it consists of a water-tight, covered vessel of tin or other suitable material, with a perforated shelf across the center. The receptacles containing the dough are placed upon this perforated shelf, and then covered with a cloth to prevent the condensation of moisture upon the surface of the dough. Warm water is then poured into the lower part of the vessel, after which it is closed by means of a cover.

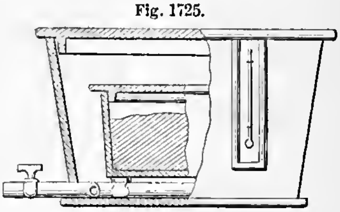
Fig. 1724.



Dough-Trough.

Fig. 1725 is on a larger scale, for the use of bakers, and consists of a box made with tapering sides and provided with a steam-pipe extending around the sides at the bottom. Inside of the box is the bread-chest, which is provided with feet, so as to elevate its bottom above the steam-pipe. The box is also provided with a thermometer, and with perforated plates.

Fig. 1725.

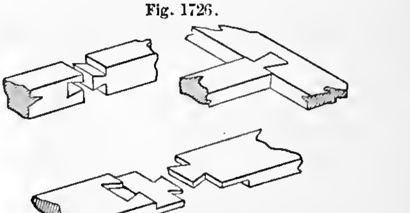


Dough-Trough.

Dous'ing-chock. (*Shipbuilding.*) One of several pieces fayed across the apron and lapped on the knighthead, or inside stuff above the upper deck.

Dove'tail. (*Joinery.*) A flaring tenon adapted to fit into a mortise with receding sides, to prevent

Fig. 1726.



Dovetails.

withdrawal in the direction of the tension it will be exposed to in the structure.

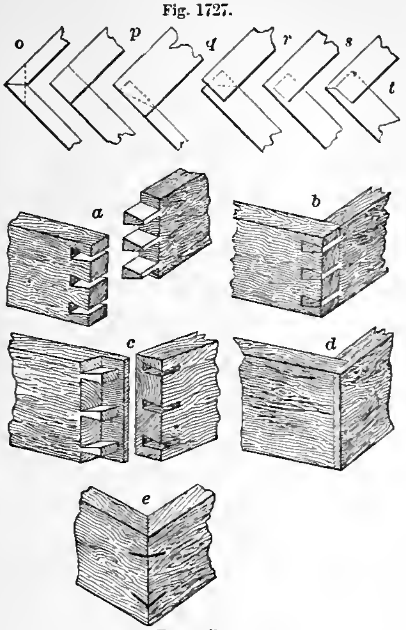
The ancient Egyptians used dovetails of wood (*joggles*) to connect stones at the corners of their edifices.

a shows the ordinary dovetail with the parts detached ; *b* the parts put together.

Concealed dovetails are made in two ways : —

c d show the *lap-dovetail*, in which a fin of wood

Fig. 1727.



Dovetails.

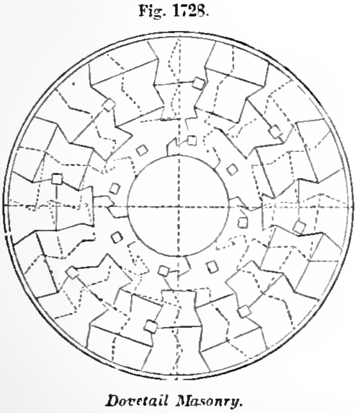
on the return edge hides the ends of the tenons and mortises.

e shows a miter-joint, locked by oblique keys of veneer. The ordinary *miter-dovetail* shows only a single line on the edge.

The series of illustrations to Fig. 1727 show the several modes of dovetailing the edges of boxes and drawers.

o is a *miter and key* joint.
p, the common dovetail-joint.
q, the *half-lap* dovetail.
r, the *secret* dovetail.
s, the *lap*-dovetail.
t, the *miter*-dovetail.

Fig. 1728.



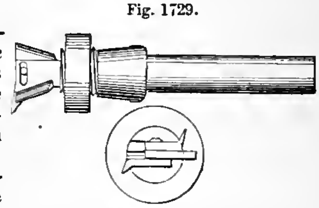
Dovetail Masonry.

Dovetailing of ashlar-work was occasionally adopted in olden times, but was first reduced to a regular system by Smeaton in the construction of the Eddystone lighthouses. The solid lines in the illustration show the 24th course of the mason-work.

Dove'tail-box Plane. (*Joinery.*) A form of rabbet-plane for dressing dovetails.

Dove'tail-cut'ter. A rotary cutter with a flaring bit used for boring dovetails.

Fig. 1729.



Dovetail-Cutter.

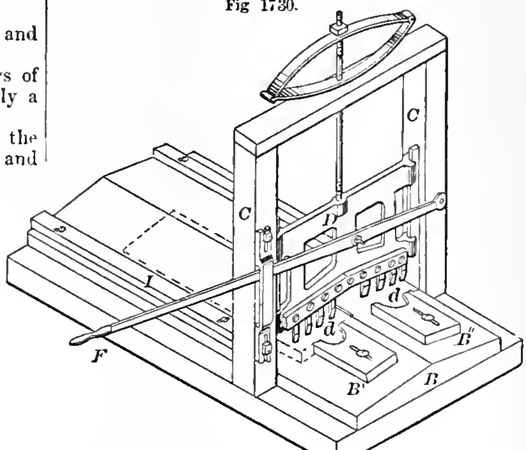
Dove'tail-file. A thin file with a tin or brass back, like the stiffener of a dovetail or tenon saw.

Dove'tail-hinge. A hinge whose leaves are wider at their outer edges than at their hinging edges.

A hinge whose attaching portions are branching and divergent, like a swallow's tail.

Dove'tail-ing-ma-chine'. A machine having a gang of chisels or saws for cutting dovetail-mortises or the kerfs therefor. In Fig. 1730, the horizontal base supports a block *B* whose upper surface consists of two equally but oppositely inclined planes *B' B''*, whose slope corresponds with the chamfer of the desired dovetails. *C C* are standards guiding to a vertical path a gate *D*, in which is fixed a series of chisels whose cutting-ends are at such an unequal elevation as to correspond with the obliquity of the planes *B' B''*. These chisels are readily adjusted to any hight and degree of separation, and are fixed to their proper positions by screw-bolts.

Fig 1730.



White's Mortising Dovetail-Machine.

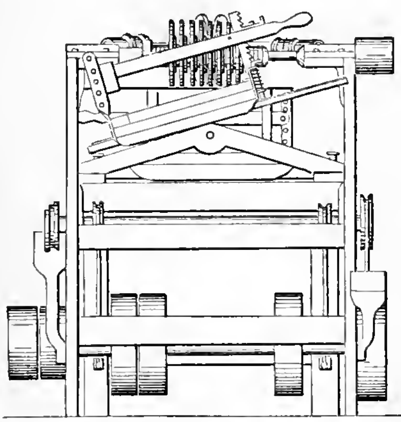
The gate is elevated and depressed by means of a lever *F*, and is gaged or arrested in its descent by a stop or shoulder. Stops on the planes *B' B''* gage the stuff. *I* is a gage for the edge of the stuff.

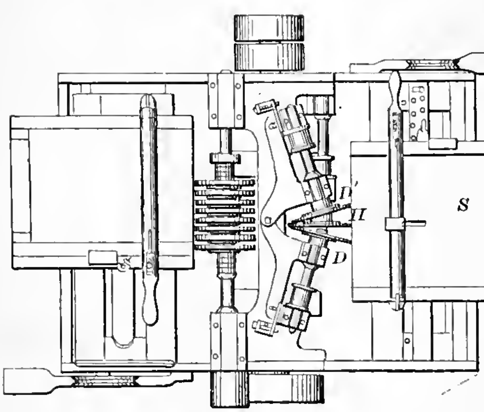
The board containing the heading-pins already sawed is placed on one of the inclines *B' B''*, and the chisels, being caused to descend, operate to excavate on one side the intervening stuff between the pins. The stuff being then placed on the other incline, and the gate again depressed, the excavation is completed by the cutting away of the opposite sides.

For excavating the mortises, the doubly inclined block *B* is removed, and another gate substituted for the gate *D*, in which substitute gate the chisels are so secured as to have their lower ends in a horizontal line. The stuff being placed on the horizontal bed and the chisels depressed, the surplus timber is excavated at a single stroke.

In Fig. 1731 is shown a machine in which the work is done by a gang of saws on a mandrel. The mortise-cutting portion is the right-hand part of the lower figure. In it the board is secured on

Fig. 1731.





Dovetailing-Machine.

the carriage *S*, in such position that the edge of said board projects under the saws or cutters more or less, according to the depth that the dovetailing is to be cut, which will be governed by the thickness of the stuff. The board, on being properly adjusted, is then brought in contact with the saws by elevating the table, thereby carrying the board upward to the saws *D D'*, cutting the sides of the mortise, and of any angle that may be required, by adjusting the stays in which the cutters are hung to the required angle.

The central cutter *H*, as will be seen, cuts into the board at a right line between the side saws, and as it leads in the cutting, the central portion of the mortise is cut away ; the side saws, as they follow, cut away the remainder, leaving a clean, angular mortise for the admission of the tenon.

The tenoning portion is on the other side of the lower figure, and is also shown in end elevation in the upper figure. The board is secured with its end projecting over the edge of the carriage, to which it is clamped ; the angle of the tenons being determined by the angle of the bed, as seen in the upper figure. The board and its bed are then raised to the cutters, one side of the tenons being cut at a time, together with a portion of the wood between them, which being done, the opposite side of the tenon is cut, and the remainder of the wood between them, by changing the position of the carriage.

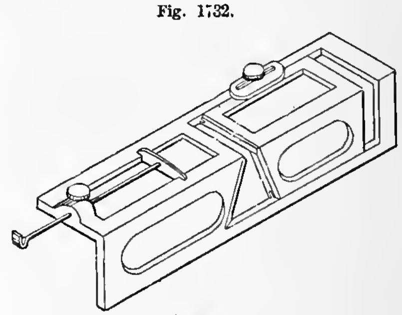
Armstrong's dovetailing-machine has two disks mounted on axes inclined to each other as well as to the main driving-shaft, one inclined to the right and the other to the left. Each disk has on its outer circumference a spiral groove, making one complete turn, into which is fitted a saw composed of segments, so arranged as in one complete revolution to give both the longitudinal and transverse cut necessary to finish a dovetail, one half being made by one disk and the other half by the other.

Other kinds operate by means of cutters, of form corresponding to that of the recesses to be made. The work is presented and fed on a table with the required adjustments.

Dove'tail-joint. The junction of two pieces by means of splayed tenons and corresponding mortises of the respective parts. See DOVETAIL.

Dove'tail-mark'er. A device for marking the dovetail tenons or mortises on the respective boards. The two plates of the frame are set at right angles to each other, and each has a scribing edge adapted to mark its side of the dovetail ; one plate is adjustable to regulate the widths and distances, the ad-

Fig. 1732.



Dovetail-Marker.

justable gage-plate affording a guide in setting the marker for the next scribe.

Dove'tail-plane. (*Joinery.*) A side-rabbet plane with a very narrow sole, which may be made by inclination to dress the sides of dovetail tenons or mortises.

The side-rabbet plane may have an under-cutting bit with a flat lower edge, so as to conform to the shape of the mortise.

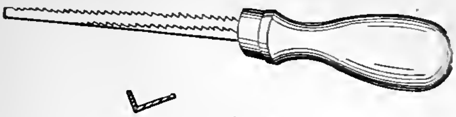
Dove'tail-saw. 1. One for cutting the dovetail-tenon on the ends of boards ; or cutting the dovetail-mortises in the faces or ends of boards to receive the said tenons. There are several varieties. One consists of a pair of circular saws running in planes, bearing such angular relation to each other as to give the required obliquity to the kerfs. In dovetailing-machines rotary cutters work to a given line, and also remove the material between the cheeks of opposite dovetail-tenons. Gangs of circular saws on a mandrel are constructed and arranged to do the same. (See F g. 1731.)

2. A small tenon-saw adapted for cutting dove-

tails. It has 15 teeth to the inch, and is usually about 9 inches in length.

3. A saw having two cutting edges, one at right

Fig. 1733.



Dovetail-Saw.

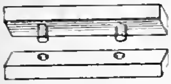
angles to the other; one edge makes the side kerf, the other the bottom kerf.

Dove'tail-wire. A kind of wire, wedge-shaped in cross-section.

Dow. A two-masted Arabian vessel. See Dhow.

Dow'el. 1. A pin used to connect adjacent pieces, penetrating a part of its length into each piece at right angles to the plane of junction. It may be permanent and glued into each piece, as in the boards forming the *leaf* of a table. Or it may serve as a joint to hold detachable pieces in position, as the *parts* of a *flask*.

Fig. 1734.



Dowel.

The slabs of calcareous gypsum or "Mosul marble" which line the adobe palaces of Nimroud were united by wooden and bronze *dowel-pins*. The several blocks in each layer of masonry in Smeaton's Eddystone lighthouse were *cramped* together, and the layers were prevented from slipping on each other by oaken *dowels*.

2. A piece of wood driven into a wall, as a means of nailing lining or finishing work thereto. A *dook*.

Dow'el-bit. A wood boring-tool adapted to be used in a brace. The semi-cylinder which constitutes the *barrel* of the bit terminates in a conoidal cutting-edge. It is also called a *spoon-bit*. See Bit.

Dow'el-ing-ma-chine'. (*Coopering.*) A machine for boring the dowel-holes in the meeting edges of the pieces which form the heads of tight casks.

Dow'el-joint. A junction formed by means of a dowel pin or pins, such as the heading pieces of a tight barrel-head.

Dow'el-pin. A pin or peg uniting two portions, as the pieces of heading for a cask. A *dowel*.

Dow'las. (*Fabric.*) Probably named from Doullens, a town of Picardy in France. A coarse linen cloth for household uses.

"Filthy dowlas," says the Bird of Avon.

Down-cast. (*Mining.*) The ventilating-shaft of a mine, down which air passes to the workings; as opposed to the *up-cast*.

Down-haul. (*Nautical.*) A rope for hauling down a staysail, jib, or other fore-and-aft sail. With staysails it passes along the stay through the cringles of the sail, and is attached to the upper corner.

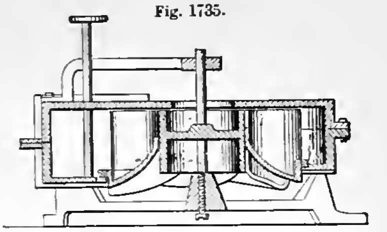
Down-share. A turf-paring plow, used in England, where the rolling treeless tracts are called *downs*. These tracts in Sussex are the homes of the Southdown sheep. (A. S. *Dun*, *dune*, a hill.) The sand-banks which lie upon the sea-shores of Holland are called *dunes*; hence Dunchurch in England, Dunkirk in the Low Countries. Hence also the Downs, the famous anchorage off the coast of Kent, England, where the Goodwin Sands form a breakwater: —

"For whilst our pinnace anchors in the Downes."
2 Henry VI., iv. 1.

Dows'ing-chock. See Dousing-chock.

Down'ward-dis'charge Wa'ter-wheel. One form of the turbine or reaction water-wheel. The water is admitted at the periphery, from a spiral chute

Fig. 1735.



Downward-Discharge Water-Wheel.

which surrounds the wheel, and, passing inward in a radial direction, curves and descends vertically.

Drab. 1. (*Fabric.*) A thick woolen cloth of a dun color, inclining to reddish-brown.

2. A wooden box used in salt-works for holding the salt taken from the boiling-pans.

Drab'bets. (*Fabric.*) A coarse linen duck.

Drab'ler. (*Nautical.*) A piece of canvas laced on the bonnet of a sail, being an extension of the bonnet, as the latter is of the sail proper.

Dradge. The inferior portions of ore detached from other portions by the *cobbing*-hammer. The better parts are known as *prill*.

Draft. 1. The current of air which supplies a fire. When this is not mechanically aided, it is called a *natural* draft. When driven mechanically, it becomes a *forced* draft or *blast*. See Bellows; Blast; Blowing-machine; Fan, etc.

It is also known as *cold* or *hot* blast, according to the temperature; that of the external atmosphere, or artificially heated.

2. (*Steam-boiler.*) The course or direction of the hot air and smoke; as, —

A *direct*, a *reverting*, a *split*, or a *wheel draft*.

3. A plan or delineation.

4. The drawing or pulling of a load or vehicle. In this connection the word forms a part of many compound words; as, —

Draft-bar.	Draft-rod.
Draft-hole.	Draft-spring, etc.

See also Draw; Drag.

5. (*Masonry.*) Chisel-dressing at the angles of stones, serving as a guide for the leveling of the surfaces.

6. (*Pattern-making.*) The amount of taper given to a pattern to enable it to be withdrawn from the mold, without disturbing the loam.

7. The depth a ship sinks in the water.

8. The combined sectional area of the openings in a turbine water-wheel; or the area of opening of the sluice-gate of a fore-bay.

9. (*Weaving.*) The arrangement of the heddles so as to move the warp for the formation of the kind of ornamental figure to be exhibited by the fabric. Known also as *drawing*, *reeding-in*, *cording of the loom*.

In every species of weaving, whether direct or cross, the whole difference of pattern or effect is produced, either by the succession in which the threads of warp are introduced into the *heddles*, or by the succession in which those *heddles* are moved in the working. The *heddles* being stretched between two shafts of wood, all the *heddles* connected by the same shafts are called a *leaf*; and as the operation of introducing the warp into any number of leaves is called *drawing a warp*, the plan of succession is called a draft.

Draft-bar. 1. A swingle-tree, double or single.

2. The bar of a railway-car with which the coupling is immediately connected.

Draft-box. Invented by Parker. An air-tight tube by which the water from an elevated wheel is conducted to the tail-race. It is a means of availing the whole fall without placing the wheel at the bottom of the same.

It is sometimes used to avoid extreme length of wheel-shaft; at other times to conform the arrangements to the peculiar location, rendering it necessary to place the wheel at a distance above tail-water.

Draft-en'gine. (*Mining.*) An engine (usually steam) for elevating ore, coal, miners, etc., or for pumping out water.

Draft-e'qual-iz'er. A treble tree; a mode of arranging the whiffletrees when three horses are pulling abreast, so that all possess an equal leverage.

Draft-fur'nace. A reverberatory air-furnace; one in which a blast is employed.

Draft-hole. The hole whereby a furnace is supplied with air.

Draft-hook. One of the hooks on the cheeks of a gun-carriage to maneuver it, or attach additional draft-gear in steep places.

Draft'ing In'stru-ments and Ap-pli'ances.

Arcograph.
Bow-pen.
Bow-pencil.
Camera (*Obscura* and *Lucida*).
Cecograph.
Centrolinead.
Chiragon.
Compasses (varieties, see COMPASS).
Copying-instrument.
Crayon.
Curve.
Curvilinear.
Curvograph.
Cyclograph.
Diagonal scale.
Dividers.
Dotting-pen.
Double drawing-pen.
Double-jointed compass.
Drafting-board.
Drafting-scale.
Drawing-compass.
Drawing-pen.
Drawing-pin.
Eidograph.
Elevation.
Ellipsograph.
Everpoint-pencil.
Fountain-pen.
Froude's compass.
Geometric pen.
Gold pen.
Hair-pencil.
Helicograph.
Ink-well.
Isometrical projection.
Lead-pencil.
Leg.
Lengthening-pen.
Manifold-writer.
Map-measurer.
Micrograph.
Music-pen.
Music writing-machine.
Napier's compass.
Needle-holder.
Optigraph.
Palette.
Pantograph.
Parallel ruler.
Pastel.
Pen.
Pencil.
Pencil-case.
Pencil-sharpener.
Pen-holder.
Pen-knife.
Pen-maker.
Pen-rack.
Perspective instrument.
Perspectograph.
Pillar-compass.
Plan.
Planimeter.
Plotting-scale.
Polygraph.
Port-crayon.
Profile.
Proportional compasses.
Protracting-bevel.
Protractor.
Quill-pen.
Reticulation.
Right-line pen.
Roulette.
Rule.
Ruler.
Ruling-pen.
Scale. Drafting
Sciograph.
Scorer.
Scotograph.
Section.
Sector.
Silhouette instrument.
Slate.
Slate-pencil.
Sliding-rule.
Spirals. Instrument for drawing
Square.
Station-pointer.
Steel-pen.
Straight-edge.
Tablet.
Tangent-scale.
Tracing-instrument.
Trammel.
Triangle.
Triangular compass.
T-square.
Tube-compass.
Universal-compass.
Vertical plan.
Whole-and-half compass.

Draft'ing-scale. A straight edge graduated with scales of chains and tenths, or inches and twelfths, for platting surveys, or drafting plans or elevations of machinery or other structures.

Draft-reg'u-la'tor. A means for opening and closing furnace-doors, or dampers in the air, draft, or discharge flue, so as to urge the fire or moderate its intensity respectively, as it may lag below or quicken above the desired standard.

Automatic devices for this purpose are actuated by arrangements known as *thermostats.* These usually depend upon the expansion of metal by heat and its consequent contraction as it cools. The lengthening or shortening of a metallic rod is the actuating force which is communicated by levers or other mechanism to the door, register, or damper. As a certain relation exists — under ordinary conditions — between the heat of steam and its pressure, the heat or pressure of steam acting on a column of mercury may be made by electric connection to actuate a magnet, and so operate the device which governs access of air to the furnace, or determines the area of the flue by which the volatile results of combustion are discharged. See DAMPER.

Draft-rod. (*Plow.*) A rod extending beneath the beam from the *clevis* to the *sheth* and taking the strain off the *beam.*

Draft-spring. A spring intervening between the tug or trace of a draft animal and the load, whereby a jerking strain upon the animal is avoided. It was invented and used by Sir Alexander Gordon. Draft-springs are connected to the draw-bars of railway cars, to lessen the violence of the jerk in starting.

Drag. 1. (*Husbandry.*) A heavy description of harrow.

2. (*Nautical.*) A floating anchor, usually a frame of spars and sails, to keep a ship's head to the wind and lessen the speed of drifting. See DRAG-ANCHOR.

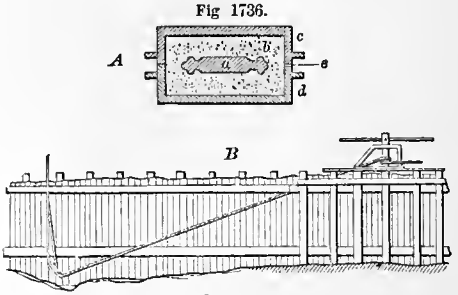
3. (*Vehicle.*) *a.* A shoe to receive the wheel of a vehicle to stop its revolution, and by friction on the ground lessen the speed of the vehicle down hill. See WAGON-LOCK.

b. A rough, heavy sled for hauling stones off a field, or to a foundation. A stone-boat.

c. A kind of four-horse vehicle used by sporting characters.

4. (*Molding.*) *A*, the bottom part of a mold, as distinguished from the cope.

Fig 1736.



Drags.

a, object cast.
b, loam.
c, cope.
d, drag.
e, parting.

5. (*Hydraulic Engineering.*) *B*, a scoop having a long flexible handle and operated by a winch, for

deepening a channel, scraping a place for a submerged foundation, or removing the mud, etc., from the inside of a coffer-dam. A form of dredging-machine.

6. (*Sawing.*) The carriage on which a log is dogged in a veneer saw-mill. The drag has two motions, one past the saw to yield a veneer, and the other at right angles to the same and equal to the thickness of the veneer, plus the width of the kerf. See VENEER-SAW.

7. A net or four-clawed grapnel used in *dragging* a pond or harbor to recover the body of a drowned person, or property which has been lost overboard. A *creeper*.

8. (*Masonry.*) A thin, indented plate for scraping and finishing the surface of soft stone.

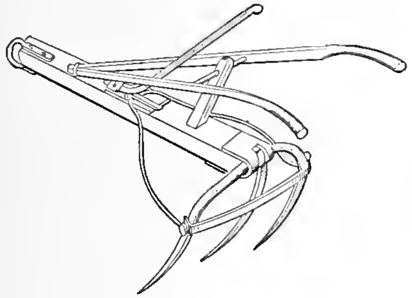
9. (*Marine Engineering.*) The difference between the speed of a screw-ship under sail, and that of the screw when the ship outruns the latter. See SLIP.

The difference between the propulsive effects of the different floats of a paddle-wheel.

10. A frame of iron with an attached net to scrape up and gather oysters by *dragging* upon the bed. See DREDGE.

11. (*Husbandry.*) An implement with hooking

Fig. 1737.



Manure-Drag.

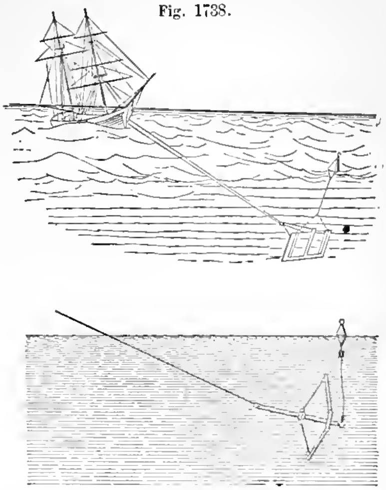
tines to haul manure along the surface. A manure-drag.

Drag-an'chor. (*Nautical.*) A frame of wood, or of spars clothed with sails, attached to a hawser, and thrown overboard to drag in the water and diminish the lee-way of a vessel when drifting, or to keep the head of a ship to the wind when unmanageable by loss of sails or rudder. It was patented under the name of a *drag-sheet*, by Burnet (English) 1826. It is sometimes made, in an emergency, of spars lashed together to form a triangular or rectangular frame, which is then covered with a sail. When constructed and carried as a part of the ship's equipment, it is made to serve as a raft or drag as may be required; but the peculiarities are generally confined to means for compact stowage and to spilling-lines for their recovery, either by collapse or reversal of position to enable them to be readily drawn in and hauled on board after having served their purpose. Treatises on navigation give illustrations of a variety of devices for this purpose, and a number are patented. One edge of the drag may be weighted, as it is essential that it be submerged, and that it should assume a position at right angles to the taut cable which connects it to the ship.

In the upper view (Fig. 1738), the drag is a wooden frame whose corners are secured by bridles or angle-lines to a cable which is made fast to the bitts on board. A buoy is attached to the upper edge of the drag, and a spilling-line enables the drag to be canted over, so as to diminish its resistance when being drawn in.

In the lower view the ribs of the wings are hinged to a hub on the shaft, so that they may expand when

Fig. 1738.



Drag-Anchors.

brought into use and may contract when the drag is upset by the spilling-line while it is being drawn in. A buoy is used, as in the drag described above, to show the position, and to keep the drag in its effective position. Braces connect the ribs to a sliding collar on the shaft, and the frame is covered like an umbrella with heavy sail-cloth lashed to the ribs.

Drag-bar. (*Railway-engineering.*) A strong iron rod with eye-holes at each end, connecting a locomotive-engine and tender by means of the drag-bolt and spring.

Drag-bench. A bench on which fillets of gold or silver are drawn through an aperture, to bring them to even and exact proportions. See DRAW-BENCH.

Drag-bolt. The strong removable bolt coupling the drag-bar of a locomotive-engine and tender together.

Drag-hook. The *drag-hook and chain* are the strong chain and hook attached to the front of the engine buffer-bar, to connect it with any other locomotive-engine or tender; also attached to the drag-bars of other railroad carriages on the English system of connection.

Drag-link. A link for connecting the cranks of two shafts; it is used in marine engines for connecting the crank on the main-shaft to that on the inner paddle-shaft.

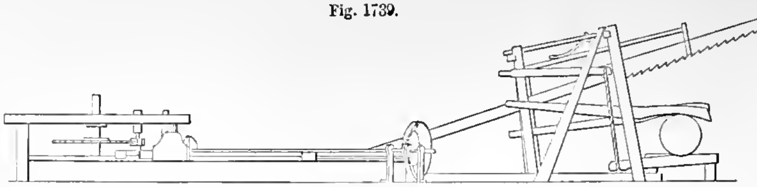
Drag'on-beam. (Corrupted from *diagonal* beam.) (*Building.*) *a.* A horizontal timber or diagonal plate used in hipped roofs and on which the foot of the hip-rafter rests. *Dragging-beam.*

b. A diagonal brace which stands under a breast-summer and whose foot rests on a shoulder of the king-post.

Drag-saw. A cross-cut sawing-machine in which the effective stroke is on the pull motion, not the thrust. In the illustration it is shown as operated by horse-power. The log is clamped by levers. The saw is held aloft by a stirrup while the log is fed forward for another cut.

Drag-sheet. (*Nautical.*) A sail stretched by spars and thrown over to windward to drag in the

Fig. 1739.



Drag-Saw.

water and lessen the lee-way of a drifting vessel. See DRAG-ANCHOR.

Drag-spring. (*Railroad.*) *a.* A spring attached to the *drag-bar* to lessen the jerk when starting up or increasing speed.

b. A strong spring placed near the back of the tender. It is attached by the ends to the drag-bar which connects the engine and tender, and by the center to the drag-bar which connects the train to the tender, according to the English mode.

Drag-staff. (*Vehicle.*) A pole pivoted to the hind axle and trailing behind a wagon or cart in ascending a hill or slope. Used to hold the vehicle from rolling backward when temporarily stopping on a hill to rest the team.

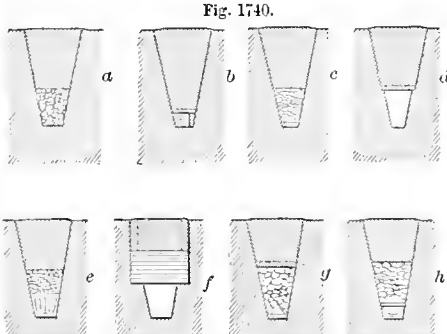
Drain. 1. A water-course to remove surface water, or so much from the subsoil as interferes with the fertility of that above it.

Covered drains are made in a variety of ways: —

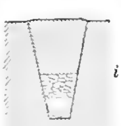
a. A layer of stones in the bed, covered by the earth which had been removed in digging.

b. Where flat stone is obtainable, two side stones and a cap, covered in with the soil.

Fig. 1740.



Drains.



c. A duct formed with a flat tile and an arched semicylindrical tile, covered in with stones, to allow percolation of water, and closed with soil.

d. In tenacious soils a shoulder may be made in the drain to support flat stones which bear the superincumbent earth.

e. Assorted, large stones in the bottom, covered in by smaller stones and a filling of soil.

f. In peaty soils the drain may be covered in with blocks of the peat or by turfs which will preserve their position for a considerable time if laid properly.

g. A bed stone and side stones to form a triangular duct covered in by stones, a layer of turf, and the filling of soil.

h. A duct formed of two semicylindrical tiles, respectively above and below a flat tile; the whole covered in by stones and the earth as before.

i. A perforated drain-pipe of circular or oval section covered in by stones and earth.

In the fen lands of Cambridgeshire, England, and other lands of the same description in adjoining counties, the main drains have generally been made $7\frac{1}{2}$ feet deep, or more in larger districts, so that the water may never rise higher than within 18 inches or 2 feet of the surface of the ground. The ladles or float-boards of the scoop-wheel dip 5 feet below the surface of the water, leaving a foot in depth below the dip of the wheel, that the water may run freely to it. The main drain brings down the water to the engine with a descent of 3 inches in a mile; 5 to 18 inches is better. Supposing that the wheel dips 5 feet below the surface of the water in the main drain, and that the water in the river into which this water must be raised and discharged has its level 5 feet above that in the drain, the wheel in such case will be said to have 10 feet head and dip, and ought to be made 30 feet in diameter.

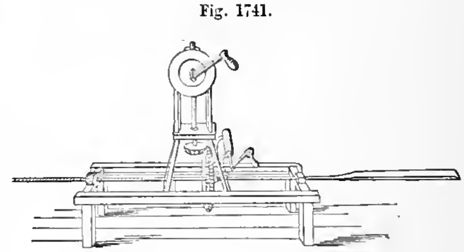
The largest quantity of water delivered by one engine is from Deeping Fen, near Spalding; this fen contains 25,000 acres, and is drained by two engines, one of 80 and one of 60 horse power. The 80-horse engine has a wheel of 28 feet in diameter, with float-boards or ladles measuring $5\frac{1}{2}$ feet by 5 feet, and moving with a mean velocity of 6 feet per second; so that the section of the stream is $27\frac{1}{2}$ feet, and the quantity discharged per second 165 cubic feet, — equal to more than $4\frac{1}{2}$ tons of water in a second, or about 16,200 tons of water in an hour.

It was in 1825 that these two engines were erected, and at that time the district was kept in a half-cultivated state by the help of forty-four windmills, the land at times being wholly under water. It now grows excellent wheat, producing from 32 to 48 bushels to the acre. The land has increased in value fourfold. See SCOOP-WHEEL.

2. (*Founding.*) The trench which conducts the molten metal to the gate of the mold.

Drain'ing-au'ger. A horizontal auger occasionally used for boring through a bank to form a channel for water. It is also used for cutting an opening for laying lead-pipe or drain-pipe. In each case it is intended to save the labor of opening a trench. It is also used for draining marl-pits or cellars, when the circumstances of the level suit."

Fig. 1741.



Horizontal Auger.

The mode of operation is as follows: the level having been determined, a spot is leveled on the down-hill side for placing the machine. The horizontal axis above is turned by two men at the hand-cranks, rotating the vertical shaft and bevel pinion which turns the larger wheel on the shaft of the auger.

When the pod of the auger is full, it is withdrawn by rotating the other handle. If hard stones be encountered, the auger is withdrawn and a chisel or drill substituted.

Drain'ing-en'gine. A pumping-engine for removing water from mines, lowlands, etc. See CORNISH ENGINE.

The *scoop-wheel* and the *baling-scoop* are much used in England. The *centrifugal pump* is used in England and the United States. The pumping-engines used in Holland at the Haarlem Mere are vertical double-cylinder condensing-engines, one cylinder within the other, the outer one being annular.

All other drainage enterprises sink into insignificance beside those of Holland.

These great public works, since their commencement in 1440, have gradually extended until they include an area of 223,062 acres drained by mechanical means. See Weale's "Dictionary of Terms of Art," pp. 277-283.

One of the latest, and the largest, of these enterprises, was the drainage of the Haarlem Lake, 45,230 acres, which was finished a few years since.

The average level of the boezem, or catch-water basin, of the district is 10 inches below the ordinary low-water, and 27 inches below high-water mark in the Y or Zuyder Zee; and 7 inches above low water, and 57 inches below ordinary high water, in the North Sea.

The bed of the Haarlem Lake is 14 feet below the winter level of the boezem, and the maximum lift may be therefore assumed to be 27 inches + 14 feet + 18 inches, — the last being the required depth of the water surface below the ground surface, to render the latter tillable, — amounting in all to 17 feet 9 inches.

The water contents of the Haarlem Mere to be pumped out, including the additional quantity arising from the surplus rain and infiltration during the draining, was estimated at 800,000,000 tons.

The greatest quantity of monthly drainage when the mere is pumped out is estimated at 36,000,000 tons, and the annual average surplus of rain-water, etc., at 54,000,000 tons, to be lifted, on an average, 16 feet.

The three engines were named the "Leeghwater," erected about 1847, the "Cruquius," and the "Lynden," after three celebrated men who had at different periods proposed plans for draining the Haarlem Mere.

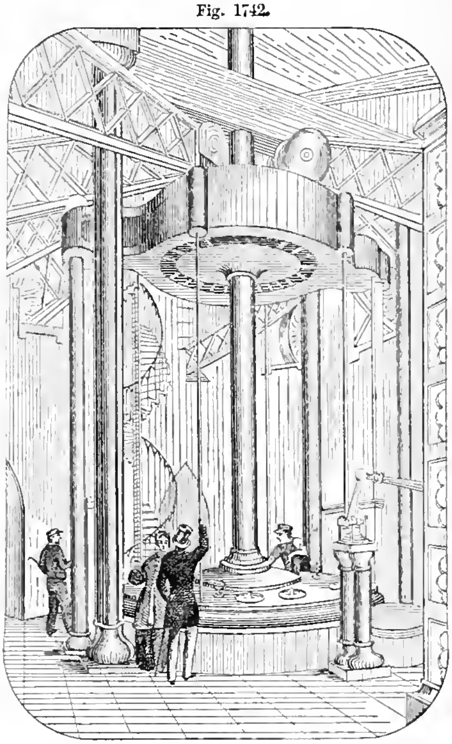
The "Leeghwater" was the first erected, to work eleven pumps of 63 inches diameter, with 10 feet stroke in pumps and steam-cylinders; and the "Cruquius" and "Lynden" were afterwards constructed, to work eight pumps each, of 73 inches diameter and with 10 feet stroke; each engine is calculated to lift 66 tons of water per stroke.

In testing the capacity of the engine for working in emergencies, using the eleven pumps simultaneously without regard to the consumption of fuel, the engine was found to lift per stroke 109 tons net of water to a hight of 10 feet. At an economical working-rate the engine performed a *duty* of 75,000,000 pounds, raised one foot high by a consumption of 94 pounds of Welch coal. The net effective force was 350-horse power, the consumption of fuel $2\frac{1}{4}$ pounds of coal per horse-power per hour.

The accompanying sketch is a representation of the interior of the "Lynden" engine and engine-house, on the upper floor; the "Cruquius" is on the same model; but the "Leeghwater" has the inner ends of its eleven pump-beams arranged under the great cross-head, instead of over it.

Each engine has two steam-cylinders, placed concentrically, the one within the other, the outer of 12 feet diameter, and the inner one of 7 feet diameter; both are secured to one bottom, and covered by one cover, but the inner cylinder does not touch the cover within $1\frac{1}{2}$ inch; there are two pistons, 26 inches deep, the compartments of which are fitted with cast-iron plates; the outer piston is annular, and has a packing on both sides; beneath this annular piston a constant vacuum is maintained when working; the two pistons are connected by five piston-rods, as shown in the sketch, to a great cross-head or cap, the whole mass weighing about 85 tons, and by eight connecting-rods the cap-pistons

Fig. 1742.



The "Lynden" Engine, Haarlem Mere, South Holland.

are suspended from the inner ends of eight cast-iron balance-beams, to the outer ends of which are hung the eight pump-pistons.

The action of the engines is very simple; the steam, being applied under the inner piston, lifts both the pistons, the great cross-head, and inner ends of pump balance-beams simultaneously, and the pump-pistons descend at the same time; by an hydraulic apparatus attached to the great cross-head, the dead weight of the pistons, etc., is arrested at the point to which it has been thrown up by the steam, and time is given for the valves of the pump-pistons to close before the down-stroke of the steam-pistons is made; then, the equilibrium-valve being opened, the hydraulic apparatus is liberated at the same moment, and the steam passing from beneath the small piston above both pistons, the pressure on both sides of the small one is equalized, while nearly two thirds of the steam acts upon the annular piston against a vacuum, and in aid of the dead weight helps to make the down-stroke in the steam-cylinder and the up-stroke in the pumps. The use of the two cylinders enables the engineman, by judiciously altering the expansion in the small cylinder, to command his work at all times, without stopping the engine to take out or put in dead weight, as would be necessary for a single-acting one-cylinder engine, where dead weight only is used for lifting the water. It has frequently occurred that the load of an engine has been added to or diminished by ten or twelve tons in the course of half an hour, by the action of gales of wind on the surface of the mere and boezem. Each engine has two air-pumps of 40 inches diameter, and 5 feet stroke. The steam is cut off in the small cylinder at from one fourth to two thirds of the stroke, according to the load ; and after expanding through the remainder of the stroke, it is still farther expanded in the large cylinder.

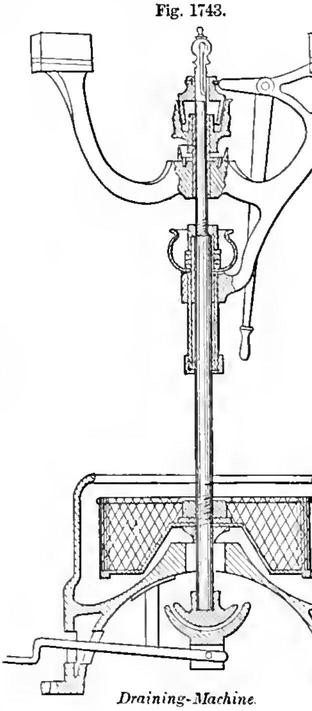
The engines were designed and constructed by Gibbs and Dean, English engineers, and the proof of quality is that upon occasion the engines have worked up to a duty of 87,000,000 pounds. The cost of the machinery and building was about $750,000.

The mere is now a tract fully subdued to the purposes of agriculture.

For elevation and plans in details of the engines, see "Civil Engineer's and Architect's Journal," Vol. X.: London, 1847.

Drain'ing-ma-chine'. A form of filter or machine for expediting the separation of a liquid from the magma or mass of more solid matter which it

Fig. 1743.



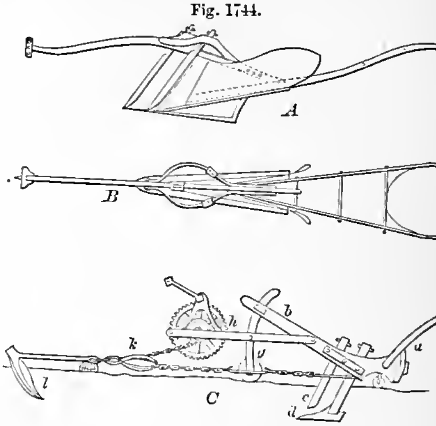
Draining-Machine.

saturates. It consists of a revolving vessel with perforated or wire-gauze outer surface, which allows the fluid portion to escape while it retains the solid particles. It is much used in draining sugar. See CENTRIFUGAL MACHINE.

Drain'ing-plow. A ditching-plow. A favorite English kind has three colters, two moldboards, and a share. It is shown at *A B* (Fig. 1744). The middle colter is vertical, and splits the soil in the middle of the furrow ; the two side cutters are inclined, to cut the sloping sides of the ditch ; the share cuts the bottom of the ditch, and the moldboards lift the soil in two slices, which are deflected laterally and delivered on the respective sides of the ditch. The usual dimensions of a ditch thus made are 12 inches deep, 15 inches wide at top, and 8 inches at the bottom.

Fowler's draining-plow (English) was exhibited in 1850, and was peculiar in the respect that it laid the drain-tile in its rear. The plow had a *mole* at the

Fig. 1744.



Draining-Plows.

end of the sharp, broad standard, and attached to the mole was a rope upon which the sections of drain-tile were strung. As the *mole* advanced, it drew in the string of tiles.

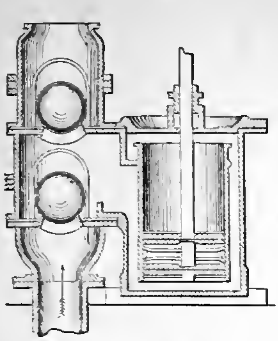
When it is desired to cut a trench deeper than can be effected by the ordinary mode of using the plow, the arrangement shown at *C* (Fig. 1744) is employed.

An anchor or hook *l* is inserted in the ground, affording a fixed point of resistance to the pulley *k*. Force is applied to the handle at the top, which communicates motion to the wheel *h*, with a very great increase of power, and the acting portions of the plow *c d* are forced through the soil. The arrangement at *a b* enables the conductor to give the required depth to the furrow. A roller *g*, resting on the ground, supports the forward portion of the plow. See EXCAVATOR.

Drain'ing-pot. (*Sugar-manufacture.*) An inverted conical vessel in which wet sugar is placed to drain.

Drain'ing-pump. A pump (*pompe castraise*) for elevating water containing sand and gravel. The single cylinder is open both at top and bottom, and is traversed by a piston without a valve. The cylinder is inclosed in a larger vessel, water-tight, which is itself filled with water. This larger vessel is divided into two equal parts vertically, by a partition which joins the working cylinder, so that the cylinder itself forms a part of the division. One extremity of the cylinder communicates with the cavity on one side of the partition, and the other with the opposite. The four valves are large balls of india-rubber, loaded in the interior with lead. They are contained in separate boxes by the side of the principal box, and are in communication by pairs with the two cavities into which that box is divided.

Fig. 1745.

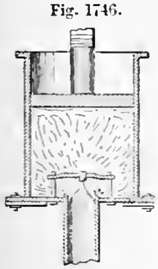


Draining-Pump.

The figure given shows a section of the cylinder, and a view of the arrangement of the pair of valves corresponding to the nearer half of the cylinder reservoir. The piston is represented as at the bottom of the stroke; as it rises the lower valve is raised by aspiration and water enters; as the piston descends the lower valve closes and the upper one rises to allow the water to flow out. The other pair of valves (not shown) have their induction and eduction by the depression and elevation of the piston respectively.

Drain-pipe. 1. (*Brewing.*) The pipe through which the *wort* is drawn from the *mash-tub* to the *under-back.*

Fig. 1746.



Pipe-Machine.

2. (*Husbandry.*) Clay pipe, known as drain-tiles, laid beneath the surface of the soil below plow depth, in order to carry off superfluous water and increase the fertility and ease of working the soil. See TILES.

The tempered clay being placed in a cylinder, the piston is depressed and the clay exudes through the annular throat of the *dod*, forming a continuous cylinder which is cut by a wire into sections of the required length.

Drain-tile. Drain-tiles are of many forms. See TILE.

They are usually laid by opening a cutting in the ground as narrow at top as can be conveniently worked, and at bottom forming a smooth bed in which the tile fits. The spades for this purpose are made tapering, and of different sizes. See SPADE; DRAIN.

Gibbs's plow for opening the ground was used in England about twenty years since, and made a trench with vertical sides, of the width for the tile to lie in.

Fowler's machine for laying drain-tiles was a mole-plow for making holes in the ground at a depth of from 2 to 4 feet, and drawing into the hole thus made a rope upon which a succession of drain-tiles was strung.

It has an apparatus attached for raising or sinking the plow, so as to lay a level drain under an uneven surface; it is drawn by the power of a windlass, and one horse's power exerted there will move the plow a yard in twenty seconds at a depth of 2 feet 6 inches. Three horses, four men, and six boys will keep two plows going, and lay 4,000 feet in a day at a depth of 3 feet. See DRAIN-PLOW; MOLE-PLOW.

A hole requires to be dug for the machine at every hundred yards, or six for an acre.

Drain-trap. A device for allowing water to pass off without admitting the passage of air through the duct. See STENCH-TRAP.

Drain-well. A pit sunk through an impervious stratum of earth to reach a pervious stratum and form a means of drainage for surface water, or a means of discharge of such liquid waste from manufactories as would foul the running water of streams. Such wells are properly termed *absorbing-wells* (which see), and by Arago are called *negative artesian-wells*, — a term more curious than profound. In former times the plain of Paluns, near Marseilles, was a morass, but was drained by means of absorbing-wells dug by King René; the waters thus carried off are said to have formed the fountains of Mion, near Cassis. The lake of Joux is supplied from the river Orbe in the Jura and the lake of Rousses, and has no visible outlet. It, however, maintains about an even level, and has evidently, as observed by Saussure, "subterranean issues by which the waters are engulfed and disappear." The inhabitants of this valley keep up their absorbing-wells with care, and open new ones 15 to 20 feet in depth whenever the surface water appears to be too slowly carried off. The waters reappear in a large spring called Orbe, two miles below the southern extremity of the lake, issuing at a point 680 feet below the level of the surface of the lake.

A potato-starch manufactory at Villetaneuse, three miles from St. Denis, France, is rid of 16,000 gallons of fetid waste water per day, with what effect upon neighboring or distant wells or springs does not appear. The town of Alexandria, Virginia, is situated upon an impervious clay of from 10 to 15 feet thickness, and a common mode of house and closet drainage is by wells which reach through this stratum into the sand substratum beneath. Good for the houses, bad for the wells of drinking-water.

Drap-d'été. (*Fabric.*) Summer cloth twilled like merino.

Draught. See DRAFT.

Draughts. See CHECKERS.

Draw; Draw'ing. A tension. The term forms part of compound words concerned in the draft of railroad-cars. Such are draw gear, head, link, spring, etc.

It also describes other attenuating processes, as the pulling of wire through an aperture in the DRAW-PLATE (which see).

The lengthening of a heated rod by hammering.

The action of rollers and other tension on slivers or rolls of fiber. See DRAWING-FRAME.

2. (*Founding.*) Said of a pattern whose shape is such that it may be withdrawn from the sand without breaking the molded form. *Delivery; draft, taper.*

3. (*Spinning.*) The *gaining* of the mule-carriage; its progress after the feed is stopped draws out the yarn.

Draw-bar. An iron rod to connect a locomotive with a tender.

Draw-bench. A machine for drawing slips of metal through a gaged opening. See DRAWING-BENCH.

Draw-bore. (*Carpentry.*) A hole so made through a tenon and mortise that the pin will draw up the shoulder to the abutment. The hole through the tenon is bored at a distance from the shoulder less than the thickness of the cheeks measured between the hole through the mortise and the face of the abutment against which the shoulder is drawn.

Draw-bor'ing. The operation of polishing a musket-barrel after it has been rifled.

Draw-boy. (*Weaving.*) Formerly the boy who pulled the cords of the harness in figure-weaving. A term sometimes applied to the mechanical device which forms a substitute for the boy. See JACQUARD.

Draw'-bridge. A form of bridge in which the span is removable from the opening to allow masted vessels to pass, or to prevent crossing.

The earliest mention of these is in the Egyptian monuments, where Rameses II. celebrated his victories over fortified cities, 1355 B. C. He is supposed to be the Sesostris of Herodotus and Diodorus. The sepulchral and palatial paintings represent the bridges as crossing the moats around castles and fortified towns.

Drawbridges are used in crossing canals, rivers, and dock entrances, which are occasionally traversed by masted vessels.

They are also used in crossing the ditches, fosses, and moats of fortifications.

They are of four kinds: —

1. The *lifting*.
2. The *swing*.
3. The *bascule*.
4. The *rolling*.

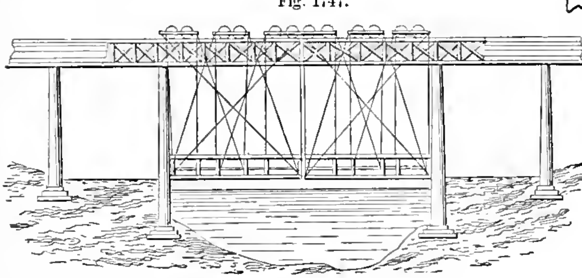
1. The *lifting-bridge* is used in Holland upon the canals and in fortifications, in places where the roadway is near the level of the water. The bridge is lifted bodily and supported by a heavy framework, while the vessel passes. See LIFTING-BRIDGE.

2. The *turning*-bridge or *swing*-bridge moves on a vertical pivot, being sometimes in two sections which meet half-way across the water-course. The portion on land is a counterpoise for that projecting over the water, and the bridge moves in arc-shaped tracks resting on cannon-balls. See SWING-BRIDGE.

It is sometimes supported by a central post and swings 90°, opening two passages for vessels, one on each side. This is a *pivot*-bridge.

3. The *bascule-bridge* turns on a horizontal pivot, standing in a vertical position on the side of the water-way while the vessel passes by. The inner end is in excess of the weight of the roadway and descends into a pit built with hydraulic masonry. This pit is not material, perhaps, in fortifications, but is not desirable in ordinary road or dock work. The *bascule* may be seen at Havre and Hull. See BASCULE-BRIDGE.

Fig. 1747.



Rolling-Bridge.

4. The *rolling-bridge* has been introduced on some English railways. The bridge passes laterally upon a carriage until it has passed the junction of the line of rails, and then rolls inward to leave the water-way clear.

In the example, the movable cars or platforms are suspended by rods and form traveling trucks, which run upon rails laid on the top of metallic tubes supported on pillars, and which serve also as viaducts, by which means the crossing of streams is afforded to traffic and travel. The tubes are to be elevated sufficiently to allow vessels to pass under the same.

Draw-cut. An oblique motion of a knife, so as to move lengthwise across an object as well as cutting into it.

Draw'er-lock. A form of inside or mortise lock which projects its bolt upwardly into the strip above.

Draw-fil'ing. Drawing a file longitudinally of a piece of metal without giving the file any movement in the direction of its length.

Draw-gage Cut'ter. A harness-maker's tool for cutting strips of leather of any set width. See GAGE-KNIFE.

Draw-gate. The valve of a sluice, either of a canal, a flushing arrangement, or a flume or penstock of a water-wheel.

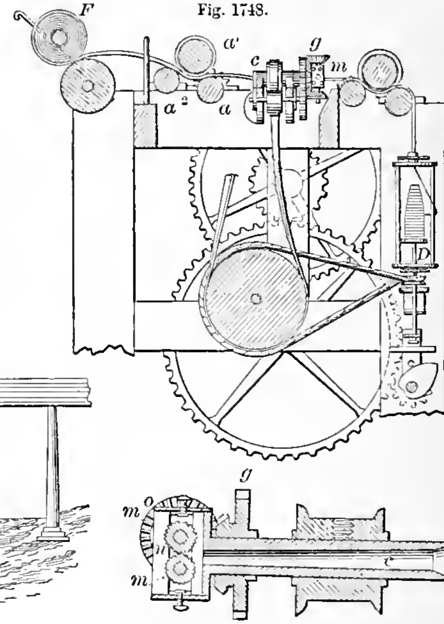
Draw-gear. The coupling parts of railroad-cars. See CAR-COUPLING.

Draw-head. 1. (*Railway.*) The projecting part of a draw-bar in which the coupling-pin connects with the link. See CAR-COUPLING.

2. (*Spinning.*) A device in spinning in which the slivers are lengthened and receive an additional twist.

A form of draw-head which lengthens the roving and twists it simultaneously is shown in Fig. 1748.

Fig. 1748.



Drawing and Twisting Head.

The process is effected in small space at one operation by means of the combined condensing-tube *c* and draw-rollers *m m*. These latter are adjustably journaled in a box *n* at the end of the tube *c*, so that they revolve with the tube on a common axis passing through the center of the tube and between the rollers. This revolution is effected by belt and pulley. They have, however, an independent motion on their own axis, at right angles to this common axis, which is derived from independent bevel-gears *o g*. The roving from the spool *F* is drawn by the first set of take-up rollers *a a'* a^2 into the condensing-tube, thence passing through the drawing-rollers *m m*, whose speed of rotation on their independent axis may be so adjusted relatively to their rotary motion in common with the tube *e* as to give any required degree of twist. The yarn then passes to the second set of take-up rollers, and thence to the spindle *D* as usual.

Drawing. 1. (*Fiber.*) Extending a sliver for the purpose of drawing its fibers parallel and increasing its length. The *drawing* and *doubling* *process* first draws out the slivers as produced by the finishing card by means of drawing-rollers, and then unites several of these into one. The object of the first operation is to draw each fiber past the next one, thus placing them still more completely parallel to each other; while that of the second is to neutralize the inequalities in each separate sliver, and to strengthen them after having been extended. See DRAWING-FRAME.

The *drawing* of long wool for worsted is somewhat similar to the operation with cotton. The slivers are combined, attenuated, and twisted ready for the farther operation of *spinning*.

Flax is drawn in substantially the same manner as cotton, some modifications in the arrangements adapting the machinery to the material.

The hackled flax, having been carefully sorted into grades of quality by the *sorter*, is spread upon a feeding-cloth by hand, in such a manner that the forward ends of each *strick* reach to the middle of the preceding one, so as to preserve a uniform thickness on the feed-cloth, the *stricks* of hackled flax being smaller at the ends than in the middle.

The flax is thus fed to one pair of rollers, which deliver it through *gills* or hackle-points to a second pair of rollers revolving at a greater speed. It is then conducted to a can.

These *slivers* are next taken to the spreading-frame, where a number of them are laid together and drawn into one length by passing between consecutive pairs of rollers, each pair rotating at a rate above that of its predecessor.

The arrangements vary in the production of different yarns, but in a given case eight slivers may be drawn into one in the first frame, twelve into one in the second, fifteen into one in the third.

Fig. 1749.

Drawing Flax.

The sliver when sufficiently equalized and attenuated proceeds to the *roving-machine*, which gives it a slight twist and winds it on bobbins ready for *spinning*.

2. (*Weaving.*) The arrangement of the heddles in accordance with the requirements of the ornament to be exhibited. The *draft* or *cording* of the loom.

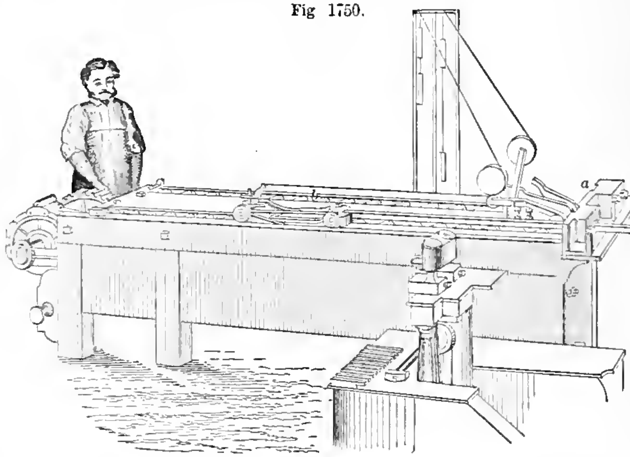
3. The making or copying of plans, and views of buildings, machinery, and other structures.

In this connection we have the compound words: —

Drawing-board.	Drawing-pen.
Drawing-compass.	Drawing-pencil.
Drawing-paper.	Drawing-slate, etc.

4. (*Metal-working.*) The operation of hammering, rolling, or drawing through a die, by which a bar or rod of metal or a wire is extended in length to form a rod, tube, or plate.

Fig 1750.



Drawing-Bench.

Draw'ing-awl. (*Leather.*) A leather-worker's awl, having a hole near the point in which the thread is inserted and pushed through in sewing, etc.

Draw'ing-bench. An apparatus invented by Sir John Barton, formerly comptroller of the British Mint. Strips of metal are brought to an exact thickness and width by being drawn through a gaged opening, made by two cylinders in the required proximity and prevented from rotating.

The cylinders are fastened in a head *a* at one end of a bench, and the sharpened end of the metallic strip is thrust through them so as to be grasped by a pair of jaws on a carriage *b*, which is retracted by an endless chain. When the strip has passed through the throat, it is automatically disengaged from the jaws, and the carriage returns. The operation is similar in principle to that of drawing wire through a *draw plate.*

Draw'ing-board. A square frame, with either a continuous surface or a shiftable panel, for holding a sheet of paper while plotting, projecting, etc.

Draw'ing-com'pass. An instrument with two legs, used for striking circles and curves. One leg has a *pen* or *pencil*, and it has several modifications, such as *bow-pen*, *bow-pencil*, *beam-compass*, etc.

Compasses for measuring and transferring measurements are called dividers, bisecting-compass, proportional compass, etc. See COMPASS.

Draw'ing-frame. 1. A machine in which the *slivers* of cotton or other wool from the carding-machine are attenuated by passing through consecutive pairs of rollers, each successive pair rotating at a higher speed than its predecessors.

The device was first invented by Leon Paul, patented 1738; and perfected by Arkwright, patent

1769. It was called a *water-frame*, from the circumstance that Arkwright's machinery was driven by water-power.

It was named a *throstle* from the brisk singing or humming sound made by it. See THROSTLE.

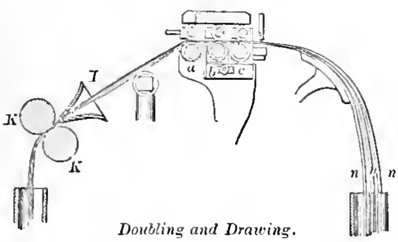
It is used in the process of doubling slivers (see DOUBLER), and is indispensable in the *bobbin-and-fly machine* and the *mule* (which see).

The *drawing-frame*, disconnected with any spinning operation, is a machine to elongate the spongy slivers produced by the carding-engine, to straighten the filaments and lay them parallel.

The drawing-frame is also used to equalize slivers by condensing a number into one (see DOUBLING), and then elongating them so as to overcome special defects. Filaments which have become doubled over the teeth of the carding-machine are also straightened in the process of doubling and drawing.

The *drawing-frame* consists of three pairs of rollers, the upper ones being covered with leather and the lower ones fluted longitudinally. The upper ones have an imposed weight, and the lower ones are driven by power, and carry those above. The rollers are driven with varying degrees of velocity; the second *b*, say, at a speed double that of the first *c*, and the third or delivery rollers *a* at a speed five times that of the second *b*.

Fig. 1751.



Doubling and Drawing.

The delivery-rollers, called the *front*-rollers, turn in brass bushes in fixed iron bearings, but the other roller-brasses are adjustable in grooves towards and from each other and the front roller, to adapt their distances to the length or staple of the cotton operated upon.

The *card-ends* or slivers *n m*, from separate cans, are united and pressed together between the rollers (*doubling*), and by the increased speed of the successive pairs are drawn out into a flat sliver, two of which are combined, passed through a funnel *I*, between compacting rollers *K K*, and thence to a can. A board above the upper rollers has flannel on its lower surface, and acts as a wiper.

The operation is as follows: —

Suppose six slivers from the carding-machine, or *card-ends*, to be inserted and passed through the first pair of rollers, the second pair, traveling at double the rate of the former, will elongate every inch of the compound sliver into two inches, and the third will make it ten inches, so that the combined sliver is formed into one of ten times the length and proportionate size; this process is repeated again and again, so that in very fine yarn the fibers are laid parallel to each other many thousands of times, and with coarse yarns as many as a thousand times. For instance: —

Ten card-ends formed into one ribbon of the same size and six times the length; six of these ribbons similarly treated and formed into one; six of the latter, by a third operation, formed into one sliver; and five of these drawn into one, — will have the effect of placing the fibers parallel to each other 1080 times ($6 \times 6 \times 6 \times 5 = 1080$).

The drawing-frame for long-stapled wool is for drawing out and extending the slivers which have already been operated upon by the BREAKING-FRAME (which see). This is a repetitive operation, and it is usual to pass the wool through the *breaking-frame* and four times through the *drawing-frame* before *roving*. These slivers are united at each drawing, and are extended to, say, four times the length. The result is an actual extension and an oft-repeated laying of the slivers alongside of each other, so as to blend them and reduce inequalities.

2. (*Silk-machinery.*) A machine in which the fibers of floss or refuse silk are laid parallel, preparatory to being cut into lengths by the *cutting*-engine, to be afterwards worked like cotton.

The order of the machines is as follows: —

Hackling.

FILLING-ENGINE (which see).

Drawing-frame; the filaments are held firmly by one end, and a comb travels over the surface to remove impurities and short fibers.

Cutting-engine reduces the filaments to a staple about 1¼ inches in length.

Scutcher.

Cleanser and *dryer.*

Carding-machine.

From whence the staple is treated like cotton. See CARDING-MACHINE; DRAWING; DOUBLING; ROVING-MACHINE; THROSTLE; BOBBIN-AND-FLY FRAME, etc. See list under COTTON, etc., p. 631.

Draw'ing-in. (*Weaving.*) The process of arranging the yarn threads in the loops of the respective *heddles*.

Draw'ing-knife. 1. A blade having a handle at each end, and used by coopers, wagon-makers, and carpenters. It is usually operated in connection with a shaving-horse, which holds the stave, spoke, shingle, axe-handle, or other article which is being shaved.

2. A tool used for cutting a groove as a starting for a saw-kerf.

Draw'ing-ma-chine'. 1. One for elongating the soft roving of fiber. See DRAWING-FRAME.

2. One for drawing a strip of metal through a gaged opening to equalize its size. See DRAWING-BENCH.

3. A form of spinning-machine for ductile sheet-metal.

Draw'ing-pa'per. A variety of large white paper, made preferably of linen stock, and of 14 sizes.

The sizes of drawing-paper are, —

Cap	13	×	16	inches.
Demy	15.5	×	18.5	"
Medium	18	×	22	"
Royal	19	×	24	"
Super-royal	19	×	27	"
Imperial	21.25	×	29	"
Elephant	22.25	×	27.75	"
Columbier	23	×	33.75	"
Atlas	26	×	33	"
Theorem	28	×	34	"
Double Elephant	26	×	40	"
Antiquarian	31	×	52	"
Emperor	40	×	60	"
Uncle Sam	48	×	120	"

These are about the usual sizes, but the scales of different makers vary to some extent.

Draw'ing-pen. A pen for ruling lines, consisting, in its most usual form, of a pair of steel blades, between which the ink is contained, the thickness of

Fig. 1752

Drawing-Pens.

the line being determined by the adjustment as to distance of the said blades.

The ends of the steel blades are elliptical, sharp, and exactly even. *A ruling-pen. A straight-line* pen.

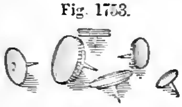
a is a *single*-drawing pen.

b, a *double*-drawing pen, for ruling two lines at once.

A *dotting*-pen makes a succession of dots, being formed of a roulette rotating in a stock. See DOTTING-PEN.

Draw'ing-pen'cil. A black-lead pencil of hard quality, made especially for drawing lines. See LEAD-PENCIL.

Fig. 1753.



Drawing-Pins.

Draw'ing-pin. A flat-headed tack for temporarily securing drawing-paper to a board. *A thumb-tack.*

Draw'ing-pli'ers. (*Wire-drawing.*) The nippers whereby the wire is grasped when pulling through the draw-plate.

Draw'ing-point. A steel tool for drawing straight lines on metallic plates. A scriber for metal. The *draw-point* or *dry-point* of an engraver makes its mark directly upon the metal, and not as the etching-point, which makes a mark through a ground, the line being subsequently eaten into the metal by acid. See ETCHING.

Draw'ing-rol'ler. The fluted roller of the drawing-machine, elongating the sliver. See DRAWING-FRAME.

Draw-kiln. A lime-kiln arranged to afford a continuous supply of lime from below, fuel and limestone being fed in above from time to time. Also called a *running-kiln*, or *continuous kiln*.

Draw-link. A connecting link for railroad cars. See CAR-COUPLING.

Draw-loom. (*Weaving.*) The draw-loom was the predecessor of the *jacquard*. It is used in figure-weaving. The number of the *heddles* being too great to be worked by the feet of the weaver, the warp-threads are passed through loops formed in strings, arranged in a vertical plane, one string to every warp-thread ; and these strings are arranged in separate groups, which are pulled by a *draw-boy*, in such order as may be required to produce the pattern. The groups are drawn by pressure on handles, the required order being determined by reference to a design, painted on paper, which is divided up into small squares.

A mechanical draw-boy has been contrived, to dispense with human assistance. It consists of a half-wheel with a rim grooved so as to catch into the strings requiring to be pulled down. The half-wheel travels along a toothed bar, with an oscillating motion from right to left, and draws down the particular cords required for the pattern.

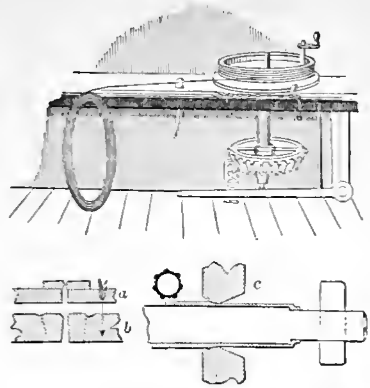
Drawn-brush. One in which the tuft or *knot* is drawn into the hole in the stock by a loop of copper wire.

This generic description includes hair, scrubbing, shoe, clothes, nail, and tooth brushes.

Draw-plate. A drilled steel plate or ruby through which a wire or ribbon of metal is drawn to reduce and equalize it.

a represents a ruby draw-plate for gold or silver wire.

Fig. 1754.



Draw-Plates and Bench.

b a draw-plate for evening the pendulum springs for chronometers.

c is a draw-plate of metal for tube drawing.

d are sections of wire of various shapes drawn through plates.

e represents forms of pinion wire.

f shows fancy forms of wire used with others as pins in the surface of a wooden block used in calico-printing.

The essential feature of wire-drawing is the *draw-plate*. This was probably known at Nuremberg early in the fourteenth century, and how much before is not apparent. The "History of Augsburg," 1351, and that of Nuremberg, 1360, mention the "wire-drawer" (*Drahtzieher*). The draw-plate was imported into France by Archal, and into England by Schultz (1565). The drawplate is probably an Oriental invention.

The draw-plate is made of a cylindrical piece of cast-steel, one side being flatted off. Several holes of graduated sizes are punched through the plate from the flat side, and the holes are somewhat conical in form. The wire is cleaned of its oxide in a tumbling-box, and is then annealed. It is then drawn through as many of the holes in succession as may be necessary to bring it to the required size. The wire is occasionally annealed to remove the hardness incident to compression in the plate, and the wire pickled to remove scale.

The sharpened end being passed through a hole in the plate, the wire is drawn through sufficiently to attach it to the wheel. This, being revolved, draws the wire through the plate and reels it up as drawn. The coil from which it is drawn is dampened with starch-water or beer-grounds as a lubricator. The Hindoo Sonârs, who are noted for their dexterity in drawing gold-wire, use castor-oil as a lubricator. Wax and tallow are commonly employed.

Strips and angle-iron of metal are made by passing through draw-plates of the required shape. The pinion-wire for watches is thus made, and also strips and rods of various forms, which are cut in sections and driven like pins into the hubs of calico-rollers, forming the dots, leaves, etc., of patterns.

For fine work, such as the drawing of gold and silver wire, the draw-hole is made of a drilled ruby. The wire for pendulum-springs of watches is drawn through a pair of flat rubies with rounded edges.

Tubes for telescopes are drawn upon a mandrel.

Gun-barrels, boiler and condenser tubes, lead-pipe, slips for music-type, window-lead, etc., are also drawn, or may be.

French *draw-plates* are described as being made by the following process: —

A piece of wrought-iron is prepared 1 inch thick, 2 broad, and 12 long. This is furrowed on one side by the peen of a hammer, so as to receive a layer of partially decarburetted cast-iron, called *potin*. This potin is made by breaking up pieces of a new iron pot, fusing them again and again with charcoal, and quenching in water. The iron partially "comes to nature," assuming the condition of steel, and is eventually melted on to the wrought-iron plate and welded thereto.

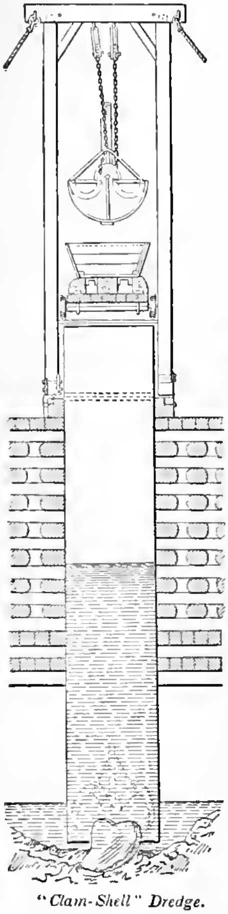
The holes are made by a punch while the iron is hot, and are very numerous in a single plate. The holes are tapered, the base of the cone being on the side of the wrought-iron.

Brockedon's English patent, 1819, specifies the use of diamonds, rubies, sapphires, and other hard gems, drilled for draw-eyes and mounted in iron plates.

Draw-point. (*Engraving.*) The etching-needle used on the bare plate. *Dry-point.*

Draw-spring. The spring of a *draw-head*. A spring coupling-device for railroad cars.

Fig. 1755.



"*Clam-Shell*" *Dredge.*

Draw-tube. The adjustable tube of a compound microscope, having the eye-piece at its outer end, and the erecting-glass (if any) at its inner end.

Dray. A low cart of an ancient type. The shafts are prolonged to form the rails, and the load is rolled upon the rear of the inclined bed.

Dread'naught. (*Fabric.*) *a.* A heavy, woolen, felted cloth, used as a lining for hatchways, etc., on board ship.

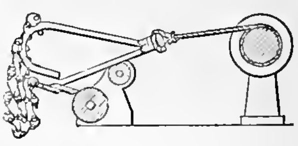
b. A heavy goods for sailors' wear.

Dredge. A scraper or drag-net for gathering mud, sand, or oysters, as the case may be, from the bottom. Mud is dredged to improve the channel, sand for making mortar, oysters from their beds, for food.

A bucket or scoop for scraping mud, sand, or silt from the bed of a stream, pond, or other body of water. Such are usually on endless chains. See Dredging-machine.

The "clam-shell" dredge used for removing the excavated material from the working-chamber of the East River, New York, bridge caisson, consists of a pair of scoops which are hinged to an axis and close upon the load, whether a mass of mud or gravel, or boulder of moderate size. The dredge ascends and descends in a vertical water-shaft in which the water rises as high as its natural level on the outside of the caisson. The view shows a portion of the working-chamber through which the dredge-shaft passes, and the numerous layers of timbers which form the roof of the working-chamber and support the masonry of the pier. The dredge is lifted with its load by the tackle above, and, being suspended above the car, the contents are dumped into the latter by shifting the points of suspension of the latter to the chains which are connected to its outer corners; this causes the scoop to gape open and spill its contents. The car is then run down an incline, and dumps its load into a lighter alongside the caisson.

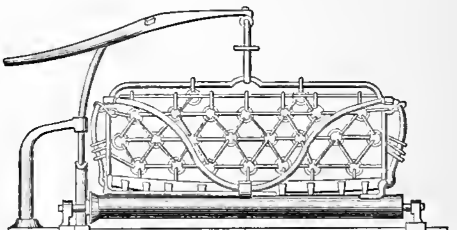
Fig. 1756.



Oyster-Dredge.

A rake and bag dragged over an oyster-bed to detach and gather the bivalves. The dredge is towed by a sail-boat, and by hand or tackle is lifted by a lever swung from a davit, and is eased over the side by a roller mounted on the gunwale, as shown in Figs. 1756, 1757. See Net; Trawl.

Fig. 1757.



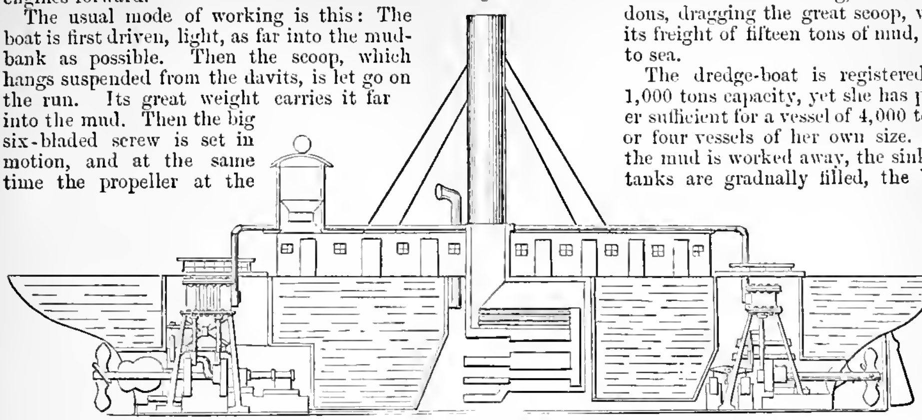
Oyster-Dredge.

Dredge-boat. A form of dredging-machine in which the boat becomes its own grubber, the depth at which the mud-fan shall operate being regulated by introduction of water into compartments of the vessel. The dredger may operate by plowing a channel through a sand or mud bar, the latter presumably, as it has been constructed to keep open the mouths of the Mississippi, allowing the current to carry off the loosened matter. A scoop is, however, to be rigged forward to plow into the mud, when the dredger will back off with its load, carry it out to sea, and dump it. The length of the vessel is 154 feet 8 inches; depth of hold, 30 feet, and about 23 feet beam. She has a screw at the after end with 3 blades, 12 feet diameter and 14 feet pitch, for propelling exclusively; and one at the forward end with six blades, 14 feet diameter, and weighing 23,900 pounds. This screw performs two offices: impelling the vessel through the water by a drawing-on process, and digging into the mud and sand. It is worked by two oscillating engines, 40-inch bore and 4-feet stroke. The three-bladed propeller is driven by a similar single oscillating engine. The steam is generated in five tubular boilers amidship. Besides the six-bladed screw for digging, there is also a large scoop or drag, in the shape of a half-cylinder, 12 feet deep, 20 feet long, and will drag away fifteen tons of mud or sand at a load. This scoop is suspended from two davits overhanging the bow, and is managed by a pair of hoisting-engines forward.

The usual mode of working is this: The boat is first driven, light, as far into the mud-bank as possible. Then the scoop, which hangs suspended from the davits, is let go on the run. Its great weight carries it far into the mud. Then the big six-bladed screw is set in motion, and at the same time the propeller at the other end commences whirling to pull the boat off. The six-bladed propeller loosens up the mud and adds to the impelling power, which, when both are working, is tremendous, dragging the great scoop, with its freight of fifteen tons of mud, out to sea.

The dredge-boat is registered at 1,000 tons capacity, yet she has power sufficient for a vessel of 4,000 tons, or four vessels of her own size. As the mud is worked away, the sinking tanks are gradually filled, the boat settles deeper in the water, and the digging-apparatus works in deeper mud.

Fig. 1758.



Dredge-Boat for Excavating.

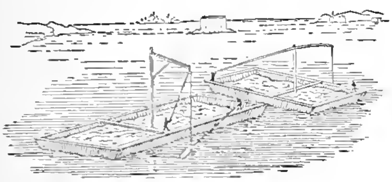
Dredg'er. 1. (*Hydraulic Engineering.*) A ballast-lighter. A barge or scow which scrapes silt from the bottom of a stream. See DREDGING-MACHINE.

2. (*Domestic.*) A box with a perforated lid for sprinkling flour upon dough or a dough-board. A *dredge-box.*

Dredg'ing-ma-chine'. (*Hydraulic Engineering.*) A machine for raising silt, mud, sand, and gravel from the bed of a stream or other water, to deepen the channel or to obtain the material for ballast or for filling low grounds.

The dredging-machine with a box shovel on the end of an oscillating arm is supposed to have originated in Venice. It had a beam 50 feet in length, moving on a pivot-post erected in a barge whose length was 50 feet and breadth 22. The beam was hooped with iron, and worked by a perpendicular screw of beech 30 feet long and 15 inches in diameter, traversing in a nut in the beam, and moved by bars in the manner of a capstan. A large iron spoon, holding $2\frac{1}{2}$ cubic yards and provided with a lid, was fixed to the outer end of the beam. To this spoon a certain rotation was given by means of ropes and

Fig. 1759.



Dredgers.

pulley, the lid opening by one motion and the spoon filling with mud by a second motion. Rotation of the screw then depressed the inner end of the beam, raising the outer end. It took fifteen minutes to raise a single scoopful. Eight men in a day would raise 60 cubic yards.

A common and cheap form of this machine, by which sand is procured from the bottom of rivers, consists of a large shovel on a long handle, suspended by a rope either from a crane or a sweep-pole. The shovel, being lowered, is thrust into the sand by one man, when the assistant proceeds to raise it and swing it round over the boat, where the contents are dumped.

This is something similar to the *bag and spoon* (Fig. 517), which consists of an iron ring with a steel lip, and a bag of strong leather laced through holes in the ring. The means for working it is a long handle, a suspending rope, and a crane or sweep-pole from a post in a barge, as in the last example.

About 1680, Meyer, a Dutch engineer, had a dredging-machine on the principle of the French chapelet; a long trough being lowered to the mud, and traversed by an endless chain provided with boards at intervals. The boards scraped up the mud and carried it up in the trough, from whose upper end it was discharged into lighters. A horse-wheel was employed.

In the reign of Charles I., Balme made a vertical wheel with six buckets, which worked between boats and raised mud. It was employed in the fens of Lincolnshire.

About 1708, Savery patented a steam dredging-machine for raising ballast from the Thames.

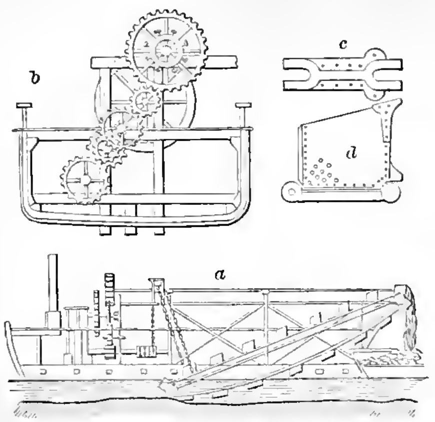
In 1796, Watt made a steam dredger for deepening Sunderland Harbor.

The dredging-machine described by the Marquis of Worcester was "a water-screw, but the bottom made of iron plate, spade-wise, which at the side of a boat emptieth the mud of a pond or raiseth gravel."

The dredging-machine described in the *Theatrum Instrumentorum et Machinarum*, 1578, was rather an elevator than a dredger. The buckets were attached to endless chains, which passed over two drums, driven by winch-power. Laborers filled the buckets.

The chapelet, used by Perronet and other French engineers in the last century for deepening channels and removing the mud from the interior of coffer-dams in preparing foundations for bridges, was composed of three rollers, two of which touched the ground, and the other was placed upon an elevated timber scaffold, where the mud and silt were deposited. Round these rollers worked an endless chain formed of large links, to which were attached four or more sheet-iron scoops or scuttles, placed at regular distances. These scoops were pierced with holes to allow the water to run off, and had strong projecting

Fig. 1760.



Steam-Dredger.

beaks which dug into the mud or earth below. The chain was moved by cylinders whose projecting spikes entered the links of the chain; the cylinder was rotated by a winch. As the buckets became inclined after turning over the upper roller, their contents were discharged into a trough which conveyed away the mud.

The steam dredging-machine, now so commonly in use in harbors liable to become silted up, has a succession of buckets on an endless chain, which traverses on a frame whose lower end is vertically adjustable so as to regulate the depth at which it works, like the French chapelet.

It was first successfully used in England by Huges in 1804, who succeeded, after repeated trials, in making a machine, costing $40,000, which raised 2,000 tons per day from a depth of water of 30 feet.

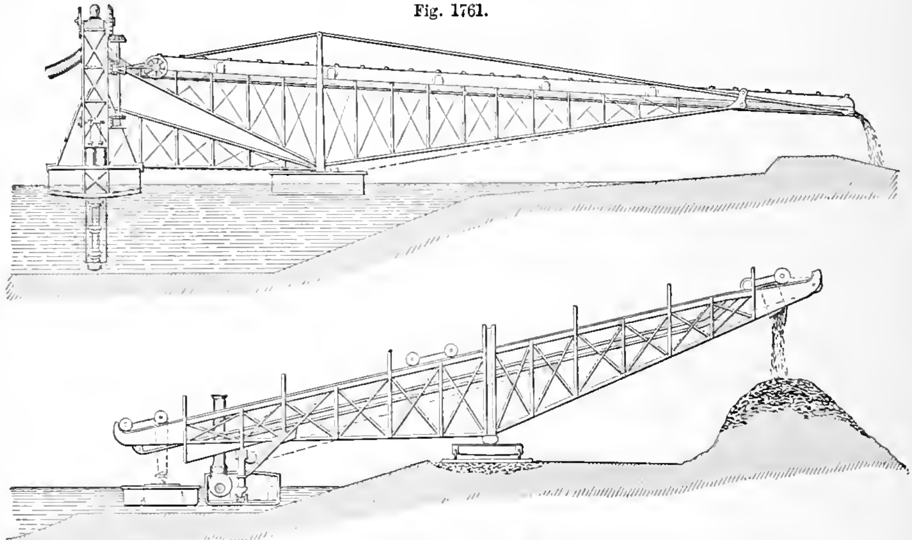
The machine is driven by a steam-engine through the intervention of gearing, steadied by a fly-wheel. A long shaft amidships conveys the motion from the gearing about the engine to the upper drum, around which the endless chain works. The buckets discharge at the stern of the vessel, dropping the mud into a lighter. The lower end of the swinging-frame is adjusted as to depth by means of a suspensory chain, which is wound upon a drum rotated by clutch-connection with the spur-gearing when necessary.

The illustrations show a longitudinal vertical section *a*; a transverse section *b*, on a larger scale, affording a view of the gearing; a plan of the link *c*, and an elevation of the bucket *d*. Each alternate link carries a bucket, which is of sheet-iron riveted to a link. The bucket and link are shown on a still more enlarged scale.

The best working-angle for the frame is 45°.

The dredging-machine used in excavating the South Boston flats has a scow 80 feet long, 40 wide, and a dredge-shovel and chain of elevating-buckets on each side. They are advanced by chains running to anchored scows, the shovel beneath each elevator raising the mud and silt, and the buckets elevating the scooped-up mass, which is deposited in a scow attached to the dredger.

Fig. 1761.



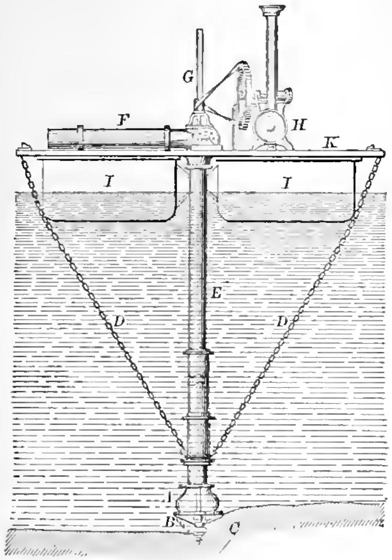
Dredging-Machines, Suez Canal.

Duncan's dredger, used on the Clyde in Scotland, has an iron hull 161 feet long, 29 feet beam, 10 feet 9 inches depth; has water-tight compartments, engine-room, and quarters for the crew. It has one bucket-chain, thirty-nine buckets having a capacity of 13 cubic feet each; driven by gearing from a marine engine of 75 nominal horse-power. It is moved forward by a steam-winch and a chain to a mooring.

Sixty dredging-machines have been at work at one time in excavating the Suez Canal. They are of two kinds, as shown in the cuts, which need but little description to make them perfectly intelligible. The hulls are of iron, are 72 or 82 feet long; one form has a lighter which gives stability, and forms a rest for the chute, 230 feet long, which deposits the excavated material on spoil-banks, whose crests are 197 feet distant from the center line of the canal. The transporting-buckets have a capacity of about 5 cubic feet, and the delivery is twenty buckets per minute. In the other view the chute rests on a carriage traveling a track on the canal-bank. In each case the buckets are loaded by the dredging-spoons, travel along the chute, capsize at the end, and return for another load. The spoil not deposited on the banks is dumped into lighters, and carried out and disgorged into the deep waters of the Mediterranean.

Another form of dredger, used at Chatham Dockyard, England, is of the rotary-pump class, having

Fig. 1762.

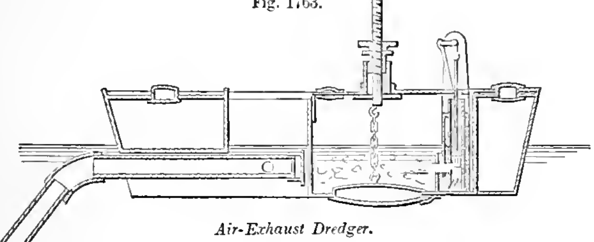


Chatham Dockyard Dredger.

a revolving disk *A* with an excavating screw *B*, an up-cast shaft *E*, and a spout *F* which discharges the material into a lighter alongside. The up-cast shaft is telescopic, and is stayed by guys *D*. The upwardly projecting rod *G* is the shaft of the revolving wheel, and is extensible coincidently with the telescopic tube. *H* is the steam-engine connecting by band-wheel and belt with the shaft *G* of the screw which excavates the mud *C*. *K* is a transverse beam of the frame which rests on twin boats *I I*.

Another mode of raising sand, silt, and mud is by an exhausted receiver in the barge, connected by an adjustable pipe and flexible connections with a

Fig. 1763.



Air-Exhaust Dredger.

spout, which is adapted to suck in the mud, upon which it rests, and discharge it into the receiver for removal and subsequent discharge at the lower valve.

The steam jet or ejector has also been used, or proposed. It differs in no substantial respect from the water-ejector. See EJECTOR.

Drench'ing-ap-pa-ra'tus. A jaw-opener and head-lifter by which drenches may be administered to animals without their being able to bite the bottle or horn, or the arm of the operator.

Drench'ing-horn. A cow's horn, closed at the butt-end and perforated at the point-end (like a powder-flask), to administer drenches of medicine to ailing animals.

Dress. Applied to the system of furrows on the face of a mill-stone. See MILL-STONE DRESS.

Dres'ser-cop'per. A vessel in which warps or threads are passed through boiling water.

Dress-guard. A wing on the side of a carriage entrance, to prevent the brushing of the dress against the wheel.

Dress'ing. Sizing of fabric, yarn, or thread.

Teaseling, or raising the nap on woolen cloth.

Preparation of mineral ores for the furnace.

Preparation of the surface of a mill-stone.

Smoothing the surface of plank or of stone.

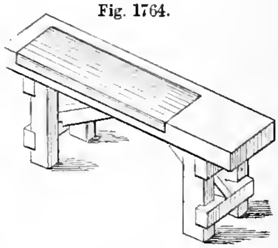
Glossing of crape-warp.

Arranging symmetrically the form in the chase.

The complete planishing of sheet-metal ware into symmetrical form, on a stake or anvil.

Dress'ing-bench. A bricklayer's bench having a cast-iron plate on which the sun-dried brick is rubbed, polished, and beaten with a paddle to make it symmetrical.

Fig. 1764.



Dressing-Bench.

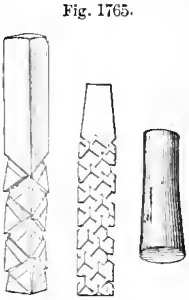
Dress'ing-ma-chine'. (*For yarn.*) A machine invented by Johnson, England, in 1800. The hard-twisted yarn is sized, scraped, brushed, and dried by heat and a blast of air. The object is to remove the fuzz and give it a slight gloss.

Dress'ings. The moldings and sculptured decorations used on a wall or ceiling.

Drift. 1. (*Machinery.*) A round piece of steel, made slightly tapering, and used for enlarging a hole in a metallic plate by being driven through it.

The drift may have a cutting edge merely upon its advance face, or it may have spirally cut grooves which give the sides of the drift a capacity for cutting, as in two of the examples annexed.

Fig. 1765.



Drifts.

2. (*Mining.*) *a.* A passage in a mine, horizontal or nearly so, forming a road for the extraction of ore, or a drain for carrying off the water. The name is derived from its being *driven in*. *Driving* is horizontal work; *sinking* and *rising* refer to the direction

of work either in shafts or in following the course of a vein. See ADIT; GALLERY.

b. The course or direction of a tunnel or gallery.

3. (*Architecture.*) The *push, shoot,* or horizontal thrust of an arch or vault upon the abutments.

4. (*Shipbuilding.*) *a.* Drifts in the sheer draft are where the rails are cut off and ended with a scroll. Pieces fitted to form the drifts are called drift-pieces.

b. The difference in size between a treenail and its hole, or a hoop and the spar on which it is driven.

c. The part of the upper strake between the coach and the quarter-deck. *Drift-rail.*

5. (*Gunnery.*) A priming-iron to clean the vent of a piece of ordnance from burning particles after each discharge.

6. A stick used in charging rocket-cases.

7. (*Nautical.*) The direction of a current. The leeway of a ship.

Drift-an'chor. (*Nautical.*) A triangular frame of wood, or other similar contrivance, having just sufficient buoyancy to float, to which a line that leads from the bows of the ship is attached. It keeps the vessel's head to wind when dismasted, or when it is impossible to carry sail. See DRAG-ANCHOR.

Drift-bolt. A rod used to drive out a bolt.

Drift-net. A fishing-net about 120 feet long and 20 feet deep; corked at the upper edge. Several of these may be connected lengthwise and attached to a drift-rope. Meshes $2\frac{1}{2}$ inches and upward, according to the size of fish.

Drift-piece. (*Shipbuilding.*) One of the upright or curved pieces of timber that connect the *plank-sheer* with the *gunwale.*

Drift-pin. A hand tool of metal driven into a hole to shape it; as the *drift* which makes the square socket in the watch-key. Holes in castings which are made by *cores* may be trued and trimmed in this way better, sometimes, than by drill or file. The tool is of steel, shaped to suit the work, and ground square on the face. See DRIFT.

Drift-sail. One dragging overboard to diminish leeway. A DRAG or DRAG-ANCHOR (which see).

Drift'way. (*Mining.*) A passage cut under the earth from shaft to shaft.

Drill. 1. A metallic tool for boring a hole in metal or hard material such as stone.

Its form varies with the material in which it works. The action in metal is usually rotative, and the tool has two or more cutting edges.

In stone drills the action is rotative or reciprocating; in the latter case the tool is alternately lifted and dropped. See ROCK-DRILL.

To drill a hole the Japanese have a short awl inserted in a round piece of stick eight or nine inches long. They take the wood between their toes, squat on the ground, and make the hole by rubbing the handle of the awl between their hands.

The bone needles of the ancient *tumuli* builders of Europe were drilled with stone drills; the eyes are small, round, and regular. The New-Zealanders, in the time of Captain Cook, were able to drill holes through glass with bone tools.

Of form of drills: —

a affords two views of the ordinary double-cutting drill used with a bow; the two edges forming the point meet at an angle of from 80° to 100°.

b is a drill for cast-iron with two circular chamfers.

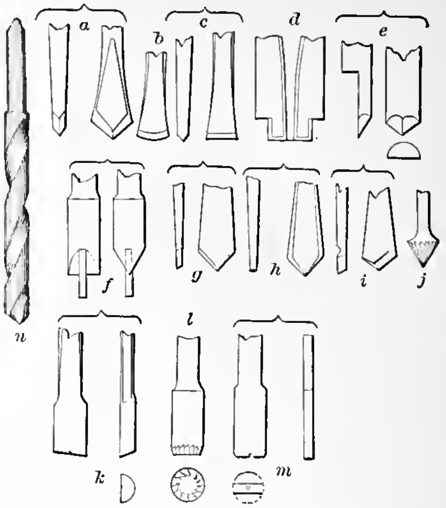
c is a flat-ended drill for flattening the bottoms of holes.

d is a duplex expanding drill for inlaying escutcheons on knife-handles, etc.

e is a drill formed of a cylindrical wire filed off to the diametric line and having two facets on the end.

f is a square countersink drill, having a guide-pin in the center.

Fig. 1766.



Drills.

g is a drill for cutting in one direction.

h, a drill for horn and other objects liable to agglutinate, and requiring great clearance.

i is the usual form of iron drill.

j is the cone countersink.

k is the half-round or cylinder lathe-bit.

l is the rose-bit for the lathe.

m is the flat-bit for the lathe.

n is the twist-drill.

See under the following list: —

Air-drill.	Drill-harrow.
Archimedean-drill.	Drill-holder.
Bench-drill.	Drilling-jig.
Bone-drill.	Drilling-attachment for lathe.
Boring-drill.	Drilling-machine.
Bow-drill.	Drill-jar.
Brace-drill.	Drill-pin.
Breast-drill.	Drill-plow.
Burr-drill.	Drill-press.
Cat-rake.	Drill-rod.
Center-drill.	Drill-rod grab.
Centrifugal-drill.	Drill-spindle.
Cherry-drill.	Drill-stock.
Churn-drill.	Drill-tongs.
Corner-drill.	Expanding-drill.
Colter-drill.	Fly-drill.
Cramp-drill.	Grab-drill.
Dental-drill.	Grain-drill.
Diamond-drill.	Hand-brace.
Differential-feed drilling-machine.	Hand-drill.
Double-drill.	Pallette.
Drill.	Persian-drill.
Drill-barrow.	Piercer.
Drill-bit.	Pin-drill.
Drill-bow.	Pneumatic-drill.
Drill-chuck.	Ratchet-drill.
Drill-extractor.	Rock-drill.
Drill-grinding machine.	Socket-drill.
Drill-gage.	Tapping-drill.

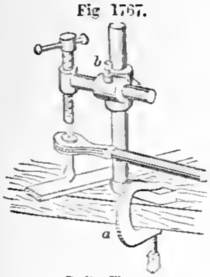
Tire-drill. Vertical-drill.
Traverse-drill. Well-drill.
Twist-drill. Wimble-drill.

2. A machine for sowing grain in rows. See GRAIN-DRILL.

3. (*Fabric.*) A heavy, cotton twilled goods, used especially for lining. *Drilling.*

Drill-clamp. A fastening device *a* for attaching a drill-holder or stock *b* to a work-bench.

Fig 1767.



Drill-Clamp.

Drill-bar'row. A seeding-machine, driven by manual power in the manner of a wheelbarrow. A hand-driven grain-drill.

Drill-bow. The bow whereby the drill is reciprocally rotated. See BOW-DRILL.

Drill-chuck. A chuck in a lathe or drilling-machine for holding the shank of the drill. See CHUCK.

Drill-ex-tract'or. A tool or implement for extracting from deep borings a broken or a detached drill which interferes with farther boring. See ARTESIAN-WELL; WELL-BORING; GRAB.

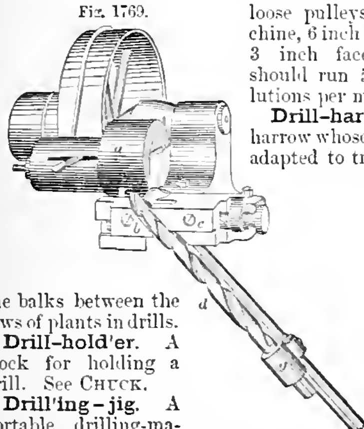
Fig. 1768.

Drill-Gage

Drill-gage. A tool for determining the angle of the basil or edge of a drill. In the example, the angular piece *C* slides by means of the thumb-screw *E* upon the part *B*, and the angle subtended by the two parts is the proper angle for the drill-point. The set-screw allows its adjustment to any sized drill.

Drill-grind'ing Ma-chine'. An emery-wheel *a* and a clamp consisting of a stationary part *b* and a movable part *c* by which the drill *d* is held near the point, while the shank is supported by the rod and extensible socket *g*. The machine is arranged to grind twist and fly drills, making cutting edges of uniform angle and length, thus insuring equality of cut upon both sides. Twist-drills up to 1 inch in diameter are held in the jaws of the clamp; split thimbles hold drills over 1 inch in diameter. Fast and loose pulleys on machine, 6 inch diameter, 3 inch face, which should run 500 revolutions per minute.

Fig. 1769.



Sellers's Drill-Grinding Machine.

Drill-har'row. A harrow whose teeth are adapted to traverse in the balks between the rows of plants in drills.

Drill-hold'er. A stock for holding a drill. See CHUCK.

Drill'ing-jig. A portable drilling-machine which may be dogged to the work, or so handled as to be readily presented to it and worked by hand.

Drill'ing-lathe. A drilling-machine on horizontal ways or shears, and thus resembling a lathe. See DRILLING-MACHINE.

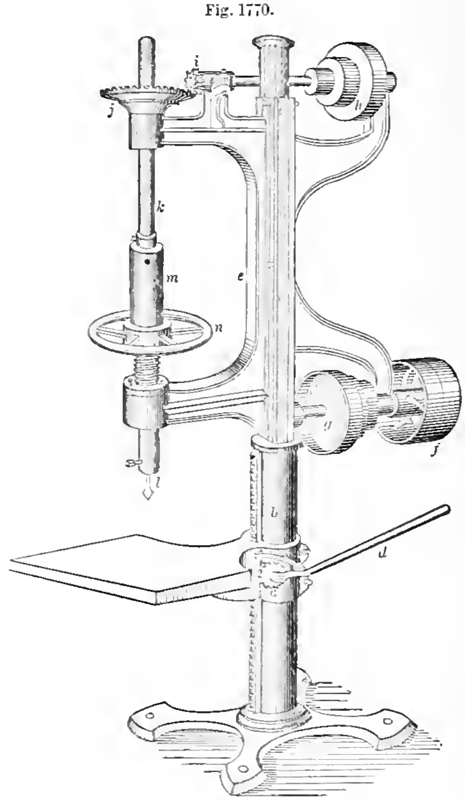
Drill'ing-ma-chine'. A machine carrying a rotating tool and a means for chucking the object to be bored. These machines differ greatly in size and appearance, in the mode of presenting the tool, presenting and chucking the work.

The larger machines are frequently known as *boring-machines* (which see).

Fig. 1770 has a vertical drill-stock *c* and vertical adjustment *d b c* to the bed-plate. The driving portions *h i j k l* and feeding devices *m n* are evident.

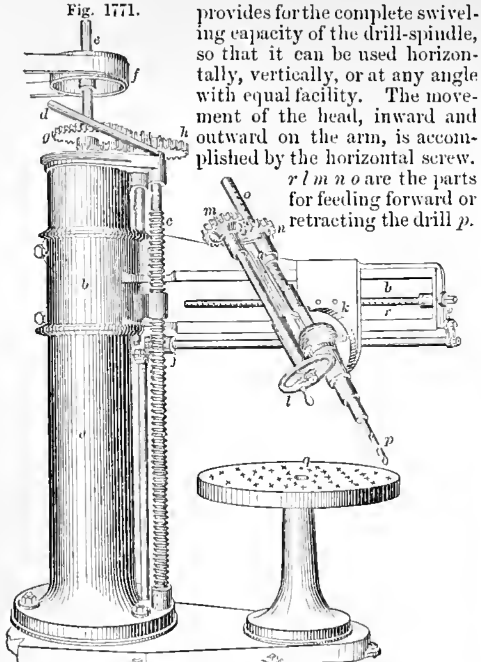
Fig. 1771 is a radial drilling-machine in which the tool, in addition to the horizontal and vertical adjustment of the overhung-beam *b*, has a circular adjustment of the drill-stock *o p* in a vertical plane, so as to present the tool obliquely to the work. The whole machine swings around a stationary post in the center of the hollow column *a*, and the overhung-beam is vertically adjustable on the latter by means of a screw *c*, actuated by power, brought into action by the lever *d* seen at the top of the column. As it is desirable that no belts should intervene to mar the complete revolving sweep of the machine, the driving is applied through the center direct by shaft *e*, pulley *f*, and gears *g h*, and transmitted to the upright shaft, whence the horizontal shaft carries it to the spindle by means of two pairs of miter-gears, one of which is shown at *j*. This arrangement also

Fig. 1770.



Vertical Drill.

Fig. 1771.



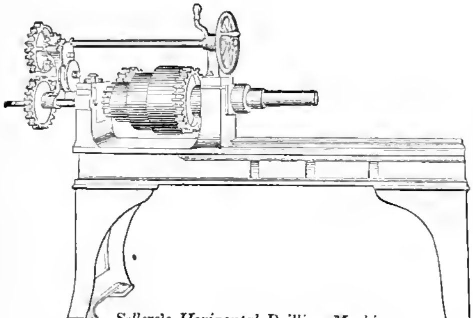
Radial Drilling-Machine.

provides for the complete swiveling capacity of the drill-spindle, so that it can be used horizontally, vertically, or at any angle with equal facility. The movement of the head, inward and outward on the arm, is accomplished by the horizontal screw. *r l m n o* are the parts for feeding forward or retracting the drill *p*.

The table *q* is for the convenience of the smaller class of work.

Fig. 1772 shows Sellers's horizontal drilling and boring machine for car-boxes, with self-acting variable

Fig. 1772.



Sellers's Horizontal Drilling-Machine.

speed to drilling-spindle. See also BORING-MACHINE.

Drill-jar. A form of stone or well-boring tool in which the tool-holder is lifted and dropped successively. The drill-rod is raised sufficiently between each impulse to loosen the tool from its impression in the stone, and is then dropped to give a blow to the tool. The tool-shank screws into the socket at the lower end of the piece *f'*.

Drill-pin. (*Locksmithing.*) The pin in a lock which enters the hollow stem of a key.

Drill-plate. A breast-plate for a hand-drill.

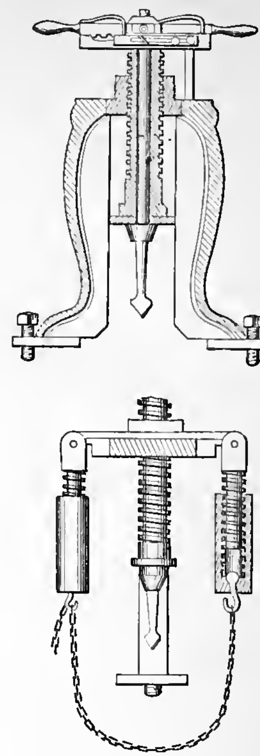
Drill-plow. A plow for sowing grain in drills.

Drill-press. 1. A drilling-machine in which a screw is made to feed the drill to its work. In the illustration, the press is shown in elevation and vertical section. It has feet for bench-work, and a

Fig. 1773.

Drill-Jar.

Fig. 1774.



Drill-Press.

sling chain and adjustable sockets when used for tapping pipes.

2. A drilling-machine of large size. See DRILLING-MACHINE; BORING-MACHINE.

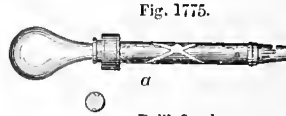
Drill-rod. The long rod, made of sections coupled together, which reaches to the surface of the ground and carries the well-boring tool on its lower end.

Drill-rod Grab. A clutching-tool lowered into a hole to engage with and form a means of withdrawing a drill-rod whose upper portion has been broken off or become detached.

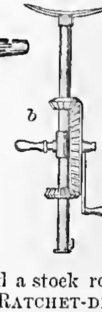
Drill-spin'dle. The axis in which a drilling-tool is stocked and on which it rotates in a drilling-machine or lathe.

Drill-stock. *a.* A handle or holder for a drill, in

Fig. 1775.



a



b

Drill-Stock

which it is socketed, and by which it is worked. Fig. 1775, *a* shows the manner in which the reciprocation of the nut in the spiral grooves of the shank revolves the drill in a uniform direction.

b is a drill with a breast-plate and a stock rotated by bevel-gearing and crank. See RATCHET-DRILL; PERSIAN-DRILL, etc.

Drill-tongs. A tool in which one jaw forms a bearing below the object, and the other carries the tool and rotative apparatus. The pressure is obtained by pressing the handles together, and an adjustable rest allows the purchase to accommodate itself to oblique surfaces.

Drip. The projecting edge of a molding or corona, channeled beneath.

Drip-joint. (*Plumbing.*) A mode of uniting two sheets of metal in roofing where the joint is *with* the *current*, so as to form a water conductor.

Fig. 1776.

Drip-Joint.

Drip'ping-vat. A tank beneath a boiler or hanging frame, to catch the overflow or drip, as that which receives the solution of indigo running from the boiler in indigo-factories.

Drip-pipe. A small copper pipe leading from the waste-steam pipe inside, to carry off the condensed steam and other hot water which may be blown into the "trap" at the top.

Drip-stick. (*Stone-sawing.*) A wooden stick whi h forms a spout to lead water slowly from a barrel to the stone, so as keep the kerf wet.

Drip-stone. 1. A corona or projecting tablet or molding over the heads of doorways, windows, arch-ways, niches, etc. Called also a *label*; *weather-molding*; *water-table*; *hood-molding*.

2. A porous stone for filtering.

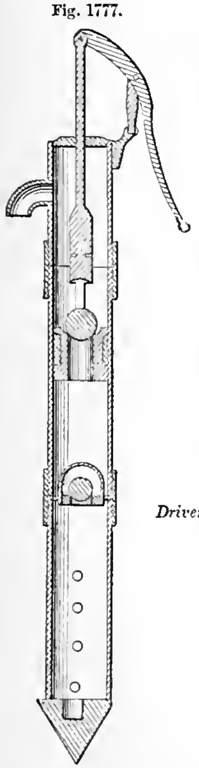
Drive. (*Forging.*) A matrix formed by a steel *punch*, *die*, or *drift*.

Drive-bolt. A *drift*. A bolt for setting other bolts home, or depressing the heads below the general surface.

Driv'en-well. A well formed of a tube driven into the ground until its perforated end reaches a stratum containing water. When the tube is driven to the desired depth, the outer tube is elevated sufficiently to expose the slots of the tube, which is secured to the barbed point.

When the proper depth has been reached, a plunger is placed in the tube, which thus forms a pump-stock of limited bore.

Fig. 1777.



Driven-Well Pump.

Fig. 1778.

Driven-Well Tube.

Driv'en-well Pump. A pump of proportions and construction adapted to occupy a tube which has been driven into the ground till its lower end has reached a watery stratum.

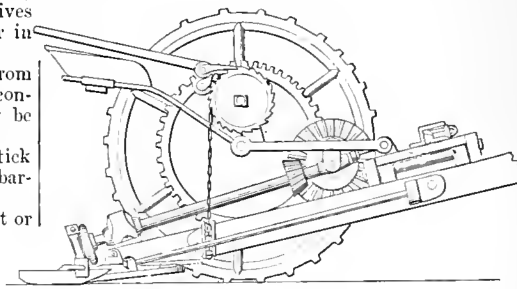
Drive-out. (*Printing.*) To space widely, to make a line of copy fill out the line, as when a mass of solid matter is divided into several *takes*, each being required to begin and end a line.

Driv'er. 1. (*Coopering.*) A tool used by coopers in driving on the hoops of casks, its tooth resting on the hoop.

2. (*Machinery.*) *a.* The wheel of a locomotive to which the power is communicated. A pair of drivers are arranged on an axle, their cranks or wrist-pins being at an angle of 90°, so that one is always in an advantageous position for duty, relatively to the piston. Several pairs of drivers are coupled together by connecting-rods.

b. In gearing, the main-wheel by which motion is imparted to a train of wheels. A *master-wheel*, as in the example, where the tread-wheel of the harvester is the agent in driving the miter-wheels and crank of the cutter-bar.

Fig. 1779.



Driver.

3. (*Milling.*) The term is applied to that which communicates motion, as the cross-bar on the spindle by which motion is communicated to the runner of a grinding-mill. A *peg*, *catch*, *tappet*.

4. (*Blasting.*) The copper bar by which the tamping is driven around the pricker on to the charge in a blast-hole. A *tamping-iron*.

5. (*Nautical.*) A four-cornered *fore-and-aft* sail, on the lower mast of a ship; its *head* is extended by a *gaff*, and its *foot* by a *boom* or *sheet*. A *spanker*.

A *ring-tail* is a sail added at the lee-leech of a driver.

6. (*Turning.*) A bent piece of iron fixed in the center-chuck, and projecting so as to meet the *carrier* or *dog* on the mandrel to which the work is attached.

7. (*Weaving*) The piece of wood which impels the shuttle through the shed of the loom.

8. A drift for enlarging a hole or giving it an angular shape not attainable by a drill. See Drift.

9. A stamp or punch; the salient tool which acts in conjunction with the *bed*, *bottom*, or *bolster*, through whose aperture the excised piece of plate is driven.

10. (*Shipbuilding.*) The foremost spur in the bulge-ways, the heel of which is fayed to the foreside of the foremost poppet, and the sides placed to look fore and aft in a ship.

Driv'ing-ax'le. (*Machinery.*) The axle of a driving-wheel; the bearing portion rests in the driving-box. The weight of that portion of the engine is supported by a *driving-spring* upon the *box*.

Driv'ing-bolt. A wheelwright's tool used for driving in nave-boxes.

Driv'ing-chis'el. A chisel basiled on each face.

Driv'ing-gear. That portion of a machine which is especially concerned in the motion; as the parts from the cylinder to the wheels, inclusive, of a locomotive; the ground-wheel to the cutter-bar pitman, inclusive, of a harvester; the hand-crank and gearing of a winch or crab, etc.

Driv'ing-rein. (*Saddlery.*) A rein which is buckled or snapped to the bit-rings and passes back to the driver. Driving-reins are known in the West as *lines*.

Driv′ing-shaft. A shaft communicating motion from the motor to the machinery.

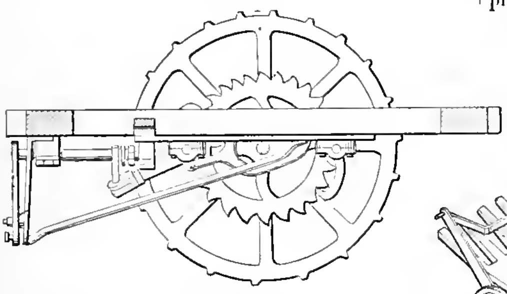
Shafting transmits power, but the *driving-shaft* is more immediate to the power; the motor.

Driv′ing-springs. The springs fixed upon the boxes of the driving-axle of a locomotive-engine, to support the weight and to deaden the shocks caused by irregularities in the rails.

Driv′ing-wheel. 1. (*Steam-engine.*) One of the large wheels of a locomotive to which the connecting-rods of the engine are attached.

In the American practice the connecting-rod is usually coupled to a wrist on the driver. This may

Fig. 1780.



Driving-Wheel.

be coupled by outside connecting-rods to other wheels of the same size, so as to make *drivers* of the latter.

In the English practice, with cylinders inside of the frame, the connecting-rods are coupled to cranks on the axle of the drive-wheels.

2. (*Harvester.*) The wheel which rests upon the ground, and whose tractional adherence thereto, as the frame is dragged along by the team, is the means of moving the gearing and giving motion to the cutter and reel.

Drog. (*Nautical.*) A buoy attached to the end of a harpoon line.

Drogh′er. (*Nautical.*) A West India cargo-boat, employed in coasting, having long, light masts and lateen sails. *Droger.*

Droitzsch′ka. A Russian traveling-carriage. See DROSKY.

Drone. (*Music.*) The base-pipe of a *bagpipe* (which see).

Drop. 1. A machine for lowering loaded coal-cars from a high staith to the vessel, to avoid the breaking of the coal by dropping it from a hight. It is a perpendicular lift in which the car is received in a movable and counterpoised cradle which is lowered and returned. A falling leaf is projected outward, to bring the wagon over the hatchway of the vessel.

2. A swaging-hammer which drops between guides. See DROP-HAMMER.

3. (*Architecture.*) An ornament depending from the triglyphs of the Doric order, *gutta*.

4. A supplementary gas-tube to lower a gas-jet. See DROP-LIGHT.

5. A theatrical stage-curtain.

6. The depth of the hanger by which shafting is supported overhead.

7. A prismatic pendant for a chandelier, to increase the brilliancy of the display by the refraction of the rays of light. It is made of a glass lump molded in a *pinching-tongs*.

8. (*Nautical.*) The depth of a sail amidships.

9. (*Fortification.*) That part of the ditch sunk deeper than the rest, at the sides of a caponniere or in front of an embrasure.

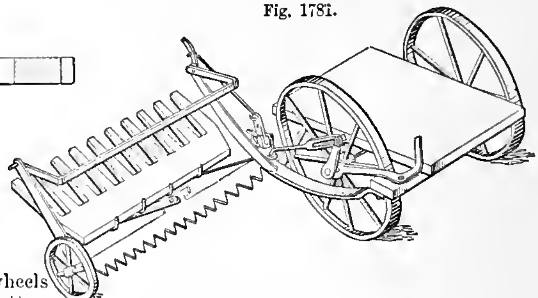
10. A falling trap-door, or hatch.

Drop-box. (*Weaving.*) A shuttle-box used in figure-weaving looms in which each shuttle carries its own color. The box is vertically adjustable by means of a pattern-chain or otherwise at the end of the shed, and, by automatic adjustment, the shuttle holding the required color is brought opposite to the shed and so as to be struck by the picker.

Drop′per. 1. One form of a reaping-machine in which the grain falls upon a slatted platform, which is *dropped* occasionally to deposit the gavel upon the ground. (Sieberling's patent.) Simultaneously with the bringing into action of the dropper, a cut-off is brought down to arrest the falling grain till the platform is reinstated.

(*Mining.*) 2. A divaricating vein, which leaves the

Fig. 1781.



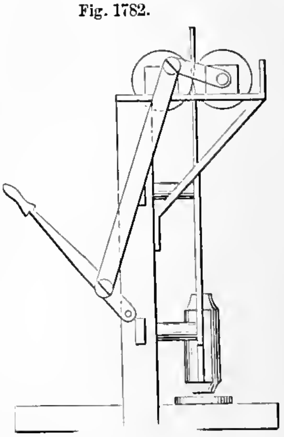
Harvester-Dropper.

main lode; or a lode which assumes a vertical direction.

Drop-flue Boil′er. One in which the caloric current descends by one or more steps or gradations, bringing it into contact with parts of the boiler in descending series; the object being to cause it to leave the boiler at the lower part, where the feed-water is introduced.

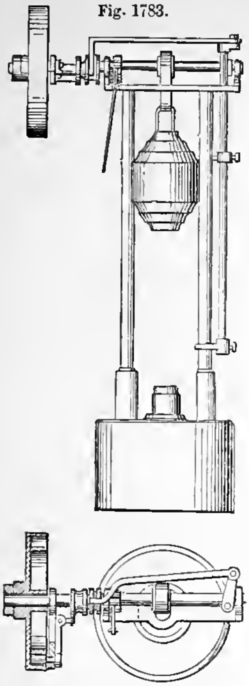
Drop-ham′mer. A hammer in which the weight is raised by a strap or similar device, and then released so as to drop upon the object below, which rests upon the anvil. It is used in swaging, die-work, striking up sheet-metal, jewelry, etc. In Fig. 1782 the hammer-strap is drawn upward by means of two pulleys, which are brought together so as to compress the strap between them. One of these, the driving-pulley, is fast upon its axle and turns in fixed bearings, while the other turns loosely upon an eccentrically journaled axis, arranged also in fixed bearings, but so as to be incapable of turning therein except as force is applied to it to effect that object. To one end of the latter shaft there is attached a horizontal arm, the outer end of which is connected to a hand-lever or treadle

Fig. 1782.



Drop-Hammer.

Fig. 1783.



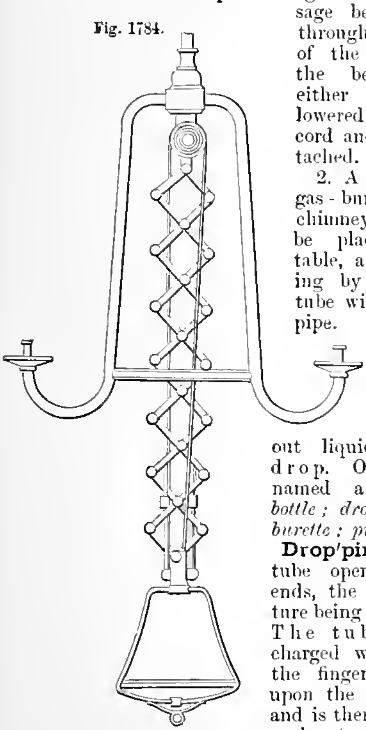
Drop-Hammer.

by a connecting-rod. By means of these appliances the eccentrically journaled shaft can be turned at will, so as to remove its roller from contact with the strap, and allow the hammer to fall through any length of space desired, within the limits of the machine.

In Fig. 1783, the hammer is raised by a strap which winds on to the main-shaft. By means of a clutch, the loose pulley is engaged with or disengaged from the driving-shaft, to raise the hammer or let it fall. An elliptical pin is journaled in an arm keyed to the shaft, and works in an annular groove in the side of the pulley. In one position of the pin it will bite between the walls of the groove and hold the pulley fast, and when turned on its axis it will release it.

Drop-light. 1. A means for placing the gas-burner at such elevation as may be convenient for reading or work, and supporting it in place without extraneous help. In Fig. 1784, a gas passage being formed through the arms of the lazy-tongs, the bell-light is either raised or lowered by the cord and pulley attached.

Fig. 1784.



Drop-Light.

2. A stand for a gas-burner and chimney, adapted to be placed on a table, and connecting by an elastic tube with the gas-pipe.

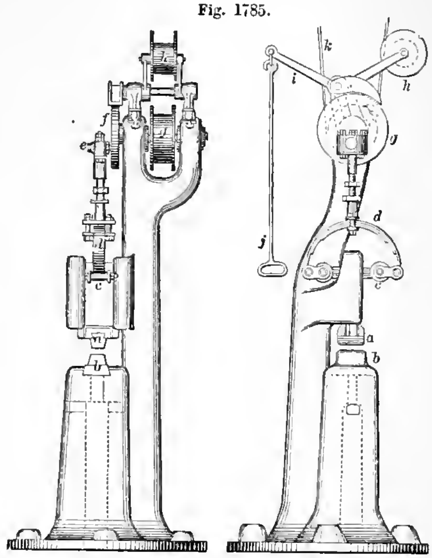
Drop-me'ter. An instrument for measuring out liquid drop by drop. Otherwise named a *dropping-bottle; dropping-tube; burette; pipette.*

Drop'ping-tube. A tube open at both ends, the lower aperture being quite small. The tube being charged with liquid, the finger is closed upon the upper end, and is then relaxed to such extent as to allow the liquid to exude in drops from the lower end. It is a small velinche.

The *dropping-bottle, pipette, burette,* and *dropmeter* have a similar purpose.

Drop-press. A form of power-hammer, not uncommonly called a press, and used for swaging as well as for ordinary forging. The machine represented has a hammer-block *a*, swung by a spring *d c* from a

Fig. 1785.



Drop-Press.

wrist on a disk *f*, which is rotated by the wheel *g* on its axis when the idler-pulley *h* tightens the band *k* against the wheel. This is done by pulling on the swinging rod *j i*, and, as soon as the rod is released and the idler falls back, the loose band runs over the wheel without rotating it. *b* is the anvil. See DROP-HAMMER; DEAD-STROKE HAMMER.

Drop-roll'er. (*Printing.*) A roller dropping at intervals to draw in a sheet of paper to the press.

Drop-ta'ble. A machine for lowering or raising weights, as in the hatchways and cellar-ways of city warehouses.

A machine for withdrawing car and locomotive wheels from their axles.

Dros'ky. A Sclavonic four-wheeled vehicle in which the passengers ride astraddle of a bench, their feet resting on bars near the ground. A *droitzschka.*

Dro-som'e-ter. An instrument for measuring the quantity of dew that collects on the surface of a body exposed to the open air during the night.

Weidler's instrument was a bent balance, which marked in grains the additional weight acquired by a piece of glass (or a pan) of certain dimensions, owing to the globules of dew adhering thereto; on the other end of the balance was a protected weight.

Another *drosometer* is substantially like a rain-gage.

Wells's drosometer was a tussock of wool weighed dry, and again after the accession of dew. Gideon on one occasion wrung out of a fleece "a bowl full of water" which was collected in this way.

Dross. The *scum, scoria,* slag, or recrement resulting from the melting of metals combined with extraneous matters.

Drove. 1. (*Masonry.*) *a.* A broad-edged chisel for stone-masons.

b. A mode of parallel tooling by perpendicular fluting on the faces of hard stones.

2. (*Hydraulic Engineering.*) A narrow irrigating channel.

Drowned-level. (*Mining.*) A depressed level or drainage-gallery in a mine, which acts on the principle of an inverted siphon. A *blind-level.*

Drown'ing-bridge. A sluice-gate for overflowing meadows.

Drug'get. (*Fabric.*) A coarse woolen fabric, felted or woven, self-colored or printed on one side; used to protect carpets.

A similar but finer article forms piano and table covers.

Drug-mill. One for grinding medicines; varying in size and construction according to the kind of drug and the resources of the establishment. The Chilian mill is used for some purposes; in the more usual form it has a rotating cone in a serrated case, like a coffee-mill, or adjacent disks, like a paint-mill. See GRINDING-MILL.

Drug-sift'er. A perforated tray or sieve either reciprocating or rotatory, inclosed in a casing, and having a drawer beneath for receiving the powder. It is usually operated by a crank.

Drum. 1. (*Machinery.*) A cylinder over which a belt or band passes.

When the cylinder bears a load, it becomes a *roller.*

A roller frequently has gudgeons to allow it to be dragged, as the *agricultural* and *garden* rollers. Such a roller (having gudgeons or axle), by the diminishing of its length sufficiently, becomes a *wheel.*

A narrow drum (*belt-bearing* cylinder) becomes a *sheave, pulley,* or *rigger.*

The *barrel* of a crane, windlass, winch, or capstan on which the rope or chain winds.

The *cylinder* on which wire winds, and whose rotation pulls it through the draw-plate.

The *grinding-cylinder* or *cone* of some mills, as the coffee or the plantation mill, etc.

2. (*Paper-making.*) A washing-drum for rags consists of a framework covered with wire gauze, in the interior of which, connected with the shaft or spindle, which is hollow, are two suction-tubes by which the water, after circulating through the rags, is carried away in a constant stream.

3. (*Calico-printing.*) One name of the cask in which steam is applied to printed fabrics in order to fix the colors. It consists of a hollow wooden cylinder with interior conveniences for suspending the cloths and covering them with flannel; after which the cover is applied and steam admitted for twenty or thirty minutes.

4. (*Architecture.*) The bell-formed portion of a Corinthian or composite capital.

5. (*Music.*) A musical instrument, formed by stretching parchment over the ends of a cylinder of wood or over a bowl-shaped metallic vessel. The skin of the ass is a very superior article for the purpose. If it were very sonorous, it would not be surprising. The Greeks used the bones of the ass for making flutes, so the animal has almost as great a compass in death as in life, which is saying a great deal. His range includes,

"The ear-piercing fife, the spirit-stirring drum."

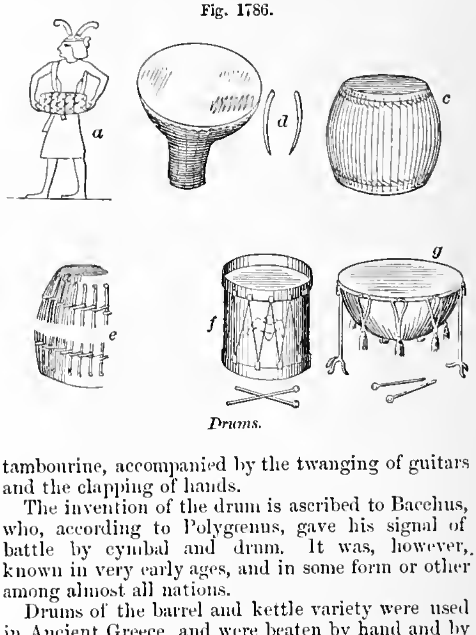
The drum was a martial instrument among the ancient Egyptians, as the sculptures of Thebes testify. Their long drum (*a*) was like the Indian tam-tam, and was beaten by the hand. It was about 18 inches long, had a case of wood or metal, and heads of prepared skin, resembling parchment. These were braced by cords in a manner somewhat similar to the modern. The instrument was carried by a belt, and was slung behind the back on a march.

An instrument similar to the *darabooka* of modern Egypt is found represented in the tombs of Thebes. It consists of a parchment-head strained over a funnel-shaped body of pottery, and is played like a tambourine.

The cuts *c c* show a drum which was found in Thebes by D'Athanasi, and show how the strings were braced. The sticks *d*, accompanying, show that it was beaten in the modern manner.

The *derbekkeh* of modern Syria is similar to the Egyptian *darabooka*, as their names indicate. Much ornament is lavished upon the cases of the Syrian instruments, as may be seen in Thomson's "The Land and the Book." Oriental nations have very imperfect ideas of melody and harmony, but are very industrious players on the drum, castanets, and tambourine, accompanied by the twanging of guitars and the clapping of hands.

Fig. 1786.



Drums.

The invention of the drum is ascribed to Bacchus, who, according to Polygrenus, gave his signal of battle by cymbal and drum. It was, however, known in very early ages, and in some form or other among almost all nations.

Drums of the barrel and kettle variety were used in Ancient Greece, and were beaten by hand and by sticks. The instrument came from Egypt, and passed from Greece to Rome.

After an interval, in which the classic civilization made a pause, the drum was re-imported into Europe by the Saracens about 713; its Arabic name, *altambor,* becoming *tambor* in Spain, *tambour* in France.

The native drums or *tam-tams* of the Asiatics are made of sonorous bronze with a skin covering, preferably a lizard skin, and are beaten by the hand. They are allied to the *darabooka* of Egypt and the Syrian drum.

The Chinese and Mandshu words for drum are onomatopoetic, and are respectively *kán-kán* and *tung-tung.*

The forms of drums among the Japanese are various,—kettle-drums, table-drums, tam-tams, suspended tambourines.

The drum of the Yucca Indians of Sonora is about 20 inches in diameter, and consists of a skin stretched on a wooden hoop. The skin is apparently that of a buffalo calf, and is tightened by cords. It has but one head, like a tambourine.

John Ziska, the Hussite, died of the plague, and before he expired ordered that his skin be made into the covering of a drum, to be beaten in the advance.

"His name shall beat the advance, like Ziska's drum."

This noted Pole fought the Emperor Sigismund, 1420–22. The latter had given a safe-conduct to John Huss, who was cited before the Council of Constance. Huss was abandoned by the Emperor to his enemies, and was burned by the Roman Catholics, July 6, 1415.

The modern drum *f* is a cylinder of brass or wood, over the ends of which parchment heads are stretched. The tension is obtained by a system of cords, and is regulated by sliding knots of leather. The head which is beaten is called the batter-head, and the opposite, across which two cords are stretched, the snare-head.

The *snare* drum has a catgut string stretched across its lower head to impart a certain quality.

The smaller drums are beaten with sticks. The larger, bass drum, is beaten with padded drumsticks.

The large drum, beaten at both ends, is called a *double-drum*. Those hanging by the side of the drummer are called *side-drums*.

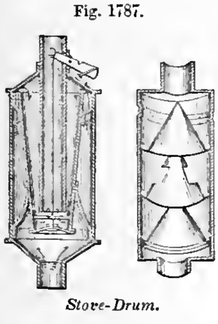
The kettle-drum *g* is so called from its resemblance to a hemispherical kettle. It is formed of thin copper, and has a head of parchment or vellum.

The small military drum is frequently called by this name. They are still used in pairs, in the English and Prussian armies and elsewhere, slung on each side of the withers of a cavalry horse. One drum was tuned to the key-note, and the other to the fifth of the key. The tuning is by a hoop and screws.

They are now usually supported upon a tripod and used in orchestras. The *tam-tam* is the original kettle-drum.

6. (*Mechanics.*) A chamber of a cylindrical form used in heaters, stoves, and flues. It is hollow and thin, and generally forms a mere casing, but in some cases, as steam-drums, is adapted to stand considerable pressure. The drums in Fig. 1787 are radiators, and the caloric current is compelled to follow a sinuous course through the drum.

Fig. 1787.



Stove-Drum.

7. A small cylindrical box for holding fruit. A keg with straight sides.

Drum-curb. A cylinder of wood or cast-iron inserted in a hole which forms the commencement of a shaft, to support a brick structure or shaft lining. The earth is dug away below the edge of the drum, and as the latter sinks the courses of brick are continually added at the top.

Drum Cyl'in-der-press. (*Printing.*) One having a large hollow cylinder. A feature in several forms of presses.

Drum-head. (*Nautical.*) The head of the capstan, having square holes to receive the bars.

Drum'mond Light. Invented by Lieutenant Drummond, Royal Engineers, during the progress of the Ordnance Survey in England, about 1826, to supply a deficiency which was found to exist in the means of making distant stations visible from each other. It is made by exposing a small ball of quicklime to the action of the oxy-hydrogen blowpipe, or the lime may be placed in the flame of a spirit-lamp fed by a jet of pure oxygen gas.

Drummond's apparatus was so constructed that the lamp fed itself automatically with spirit and with oxygen, supplying itself with balls of lime as they were gradually consumed, and was provided with a parabolic silvered copper mirror. With this apparatus the light produced by a ball of lime not larger than a boy's marble, at Londonderry, was visible at Belfast, a distance of nearly seventy miles, in a direct line. Subsequently, Colonel Colby made a lime-light signal visible from Antrim, in Ireland, to Ben Lomond, in Scotland, a distance of ninety-five miles in a straight line.

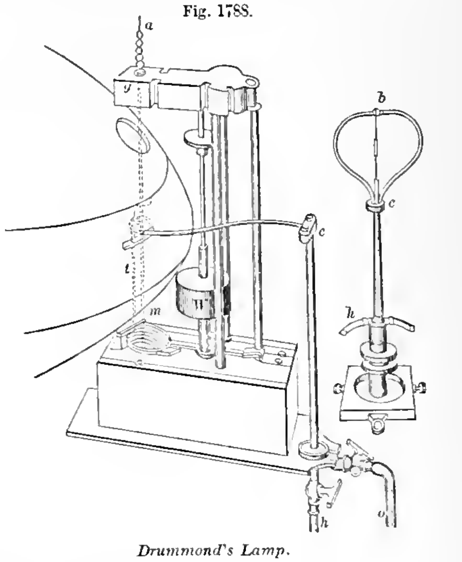
It is stated that, intensified by a parabolic reflector, it has been observed at a distance of 112 miles.

It is understood that the first application in practice was when it was required to see Leith Hill, in Surry, from Berkhampstead Tower, in Hertfordshire.

The practical application was described in two papers published in the "Philosophical Transactions of 1826 and 1831."

The apparatus consists of a lamp which admits oxygen and hydrogen gas at the respective apertures *o h*. The gases come from separate holders, and do not mix till they reach the chamber *c*. Here they pass through several thicknesses of wire-gauze,

Fig. 1788.



Drummond's Lamp.

which prevent explosion by the reflex action of the flame, and then issue at two points, being projected upon the ball *b*, which revolves once in a minute to prevent wasting at the two points where the flame impinges upon it. A ball of lime lasts about forty-five minutes, and a reserve of them is kept upon the wire *a m*, one being released periodically, and, falling upon the curved support *t*, is held in focal position, the former ball having dropped into the cistern below. *b* represents the focal ball in position; the ball at *g* falls into a position where it becomes gradually heated; at the end of that time the curved support *t*, moving on a pivot, is temporarily thrown out of its normal position by means of the weight *W*. The exhausted ball falls away, and a fresh ball falls into the focus. The wire *a b* passes through the focus of the parabolic reflector, and holes are cut in the reflector for the passage of the balls and for the curved jet-pipes, which are pivoted to the stand-pipe.

Drum-saw. A cylindrical saw for sawing curved stuff, staves especially. A *cylinder-saw; barrel-saw.*

Drum-wheel. A very ancient Oriental form of water-raising wheel which was originally drum-shaped, but afterwards had scoop-shaped buckets which dipped up water and conducted it towards the axis, at or near which it was discharged. See TYMPANUM.

Drunk'en-cut'ter. An elliptical cutter-head, placed at such obliquity on the shaft as to revolve in a circular path. A *wabbler.*

Drux'ey. Timber in a state of decay, with white spongy veins.

Dry-arch. (*Building.*) An arch employed in the foundations of buildings for the purpose of keeping them dry.

Dry-cast'ing. The process of casting in which the molds are made from sand, and subsequently dried.

Dry-dock. A dock from which the water is withdrawn after the vessel has floated into it. Advantage is generally taken of the flow-tide to introduce the vessel, and of the ebb to withdraw the water. The water flows out by sluices, and the gates point outward to resist the re-entrance of the water. A *graving-dock.*

After the great ship of Ptolemy Philopator was afloat, "a Phœnician devised a new method of docking it by digging a trench close to the harbor, equal to the ship in length. In this trench he built props of solid stone, 5 cubits high, and across them he laid beams crosswise running the whole width of the trench at four cubits distance from each other; and then making a channel from the sea he filled the excavated space with water and floated in the vessel. Then reclosing the entrance, he drained the water off by means of engines; and when this had been done the vessel rested securely on the cross-beams." — CALLIXENUS'S *Account of Alexandria,* quoted by ATHENÆUS in his *Deipnosophists,* A. D. 220.

This ship was 200 cubits long; 38 cubits beam; 48 cubits midship-hight.

Of the United States dry-docks at South Brooklyn, No. 1 is 500 feet long, 60 feet wide at bottom, and capable of receiving vessels of 12 feet draft at low water, or 18 feet at high water. No. 2 is 447 feet long, and receives vessels drawing 17 feet at low water, and 22 feet at high water. By means of a central gate this dock may be divided into two separate parts, each forming an independent dock. The pumping is done by means of a superior horizontal engine of 100-horse power, and two oscillators of 50-horse power and 30-horse power respectively. The former of these engines connects with a double centrifugal pump of mammoth proportions, and with a capacity for pumping and discharging 40,000 gallons of water per minute. At this rate the average time required for completely relieving the docks from water is about three and a half hours; the docks when full contain 8,000,000 gallons of water. The oscillators are attached to centrifugal pumps used for drainage, or keeping the docks free from water when occupied by vessels. Their average capacity is about 1,000 gallons each per minute.

Dry'er. A machine or apparatus for evaporating, driving off superfluous moisture, desiccating. The term is applied to a certain class of machines, and yet no absolute line can be drawn between it and ovens, kilns, etc. See:—

Bagasse-dryer.	Malt-dryer.
Barrel-dryer.	Manure-desiccator.
Cloth-dryer.	Oast.
Feather-renovator.	Offal-dryer.
Fruit-dryer.	Oven.
Grain-dryer.	Paper-dryer.
Kiln.	Wool-dryer.
Lumber-dryer.	

1. The heated tables or cylinders which expel the moisture from the just-formed paper, in the machine.
2. The oven which evaporates the moisture from ceramic work, giving the pieces a certain degree of rigidity and desiccation, when they are fit for the subsequent operations, according to their purpose and quality. See POTTERY.
3. An oven for drying fruit.
4. A kiln or heated cylinder for drying grain.
5. A closet for drying clothes or cloth.
6. A *core* stove.
7. In painting, a preparation to increase the drying and hardening properties of paint.

a. Litharge ground to a paste with drying oil.

b. White copperas, or sugar of lead, and drying oil.

Dry-gild'ing. A mode of gilding, by steeping linen rags in a solution of gold, burning the rags, and then with a piece of rag dipped in salt-water rubbing the ashes over the silver intended to be gilt.

The method was invented in Germany, and is first described in England in the "Philosophical Transactions" for 1698.

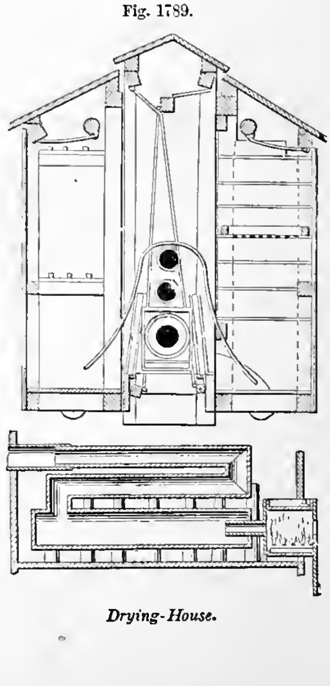
Dry-grind'ing. The cutler's mode of sharpening and polishing steel goods on a grindstone, without water.

It is very injurious to the health. Two remedies, or rather protections, are afforded: 1. ABRAHAM'S *magnetic-respirator,* which arrests the particles of steel. See RESPIRATOR. 2. Exposure of but a small portion of the stone, and a tube in the immediate vicinity of the work to carry off all the dust.

Dry'ing. The exposure of crystallizing magma sirup in a centrifugal machine, where the molasses is drained from it by mechanical action. See CENTRIFUGAL-MACHINE.

Dry'ing-house. An apartment in which anything is exposed to a current of air moderately heated; it is not easy to draw the line between an oven, a dryer, and a kiln: the words are used with some degree of carelessness, and have become technical in trades. Cores are dried in *ovens;* pottery in *ovens* or *biscuit-kilns;* fruit, lumber, and wool in *dryers;* grain in *dryers* or *kilns;* malt in *oasts;* clothes in *hot-*

Fig. 1789.

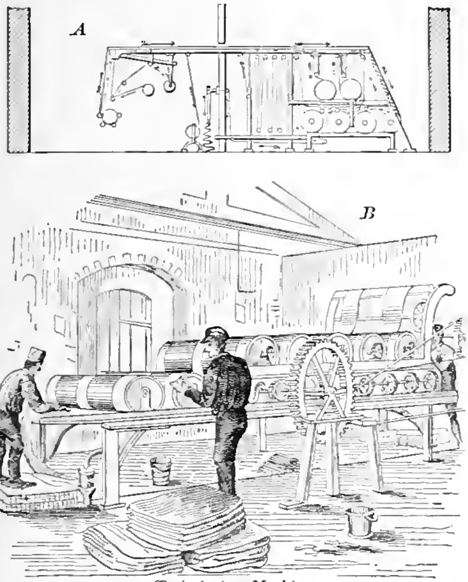


Drying-House.

closets; feathers in *renovators.* The illustration shows a dryer which has a drying-chamber comprising a central chamber and one or more wings hinged thereto, and mounted on wheels or casters for the purpose of ready access to the chambers and for removal from place to place. On one side is a suitable provision for drying clothes, and on the other for drying fruits. In the central chamber is a stove and apparatus for heating.

Dry'ing-ma-chine'. The machine for drying printed calicoes is shown by a vertical longitudinal section at *A*, Fig. 1790. The apparatus is in a hot room, and has a series of heated steam chests and cylinders with upper and lower rollers, over which the cloth is exposed to the drying air of the apartment. The arrows indicate the course of the cloth.

Fig. 1790.



Cloth drying Machine.

B, Fig. 1790, is a perspective view showing a series of heated cylinders upon which starched cotton or linen cloth is successively wound, drying and ironing it.

Similar drying cylinders are used in paper-making machines, both the cylinder machines and those of the Fourdrinier pattern, in which the sheet of pulp is felted on an agitated horizontal web.

Dry'ing Off. The operation in gilding by which the amalgam of gold is evaporated.

Dry'ing-room. The apartment in which articles or materials are dried ; as, gunpowder, calico, cores, and what-not. Sometimes a kiln.

Dry'ing-stove. A place where cores for casting are dried.

A stove for desiccating fruit, drying clothes, etc.

Dry-me'ter. A form of gas-meter in which no liquid is used. See GAS-METER.

Dry-pile. A voltaic battery in which the plates are separated by layers of farinaceous paste combined with a deliquescent salt. Known as De Luc's Column.

Dry-pipe. (*Steam-engineering.*) A pipe which conducts dry steam from the boiler. The steam is collected in such a manner as to be free from priming.

Dry-point. (*Engraving.*). The work of an etching-point upon a plate, unaccompanied with the use of acid, to deepen the line so made.

Dry-press. (*Printing.*) One in which the printed sheets are pressed smooth.

Dry-sand. (*Casting.*) A mixture of sand and loam which are employed in making molds subsequently dried in an oven.

Dry-stove. A hot-house whose atmosphere is adapted hygrometrically for preserving the plants of arid climates.

Du'al-ine. Carl Ditmar's patent, No. 98,854, January 18, 1870. The composition is : —

Nitro-glycerine . . .	50 per cent.
Fine sawdust . . .	30 "
Nitrate of potassa . .	20 "

Compared with dynamite, it is, 1. More sensitive to heat, and also to mechanical disturbances, especially when frozen, when it may even be exploded by friction ; 2. The sawdust in it has little affinity for the nitro-glycerine, and at best will hold but 40 to 50 per cent of nitro-glycerine, and on this account very strong wrappers are needed for the cartridges ; 3. Its specific gravity is 1.02, which is 50 per cent less than that of dynamite, and as nitro-glycerine has the same explosive power in each, its explosive power is 50 per cent less than that of dynamite ; [bulk for bulk ?] 4. The gases from explosions, in consequence of the dualine containing an excess of carbon, contain carbonic oxide, and other noxious gases. Lithofracteur and dualine, however, can be exploded, when frozen, by means of an ordinary fulminating cap, which is not the case with dynamite. — *Journal of Applied Chemistry.*

Dub'bing. 1. (*Leather Manufacture.*) A mixture of fish-oil and tallow which is used to protect leather against the action of water. It is rubbed into the hide after currying, and is also freely used upon the hose of fire-engines and the boots of persons exposed to wet. *Daubing.*

Another recipe : Resin, 2 pounds ; tallow, 1 pound ; train-oil, 1 gallon.

2. (*Plastering.*) Filling up with coarse stuff irregularities in the face of a wall previous to finishing it by plaster.

3. Dressing off smooth with an adze.

Dub'bing-out. (*Plastering.*) A system of bringing an uneven surface to a plane by attaching pieces of tile, slate, lath, or other matters, to the wall beneath.

A projection may be made on a wall by the same means ; pieces being attached to the wall and covered with plaster brought to shape by the trowel.

Dub'bing-tool. An instrument for paring down to an even surface. An *adze.*

Du-cape'. (*Fabric.*) A rich silk.

Duck. (*Fabric.*) A flax fabric lighter and finer than canvas.

Duck's-bill Bit. A wood-boring tool adapted to be used in a brace.

It has no lip, but the screw-cylinder which forms the barrel of the tool terminates in a rounded portion whose edge is sharpened to form the cutter. See BIT ; BORING.

Duck's-foot Pro-pel'ler. A collapsing and expanding propeller which offers but little resistance in the non-effective motion, but expands to its full breadth in delivering the effective stroke, forming a kind of folding oar which opens to act against the water when pushed outward, and closes when drawn back at the end of the stroke.

The idea was taken from the foot of a duck, and was first tried by the celebrated Bernoulli, afterwards by Genevois, a Swiss clergyman, about 1757 ; then by Earl Stanhope about 1803. It was used on the river Thames about 1830.

NAIRN'S *propelling apparatus*, English patent, 1828, has the contractile retreat and expanding advance, the *advance* being understood to mean the effective stroke.

Duc'ti-lim'e-ter. An instrument invented by M. Regnier for ascertaining the relative ductility of metals. The metal to be tested is subjected to the action of blows from a mass of iron of given weight attached to a lever, and the effect produced is shown upon a graduated arc.

Duc-til'i-ty. The quality of adaptedness for drawing into wire; as malleability is for being beaten into leaves.

The order of metals in these two respects is as follows: —

Ductility.	Malleability.
Gold.	Gold.
Silver.	Silver.
Platinum.	Copper.
Iron.	Tin.
Copper.	Platinum.
Zinc.	Lead.
Tin.	Zinc.
Lead.	Iron.
Nickel.	Nickel.

Duc'tor. A gage or straight-edge to remove superfluous material, as one on the color-roller of a calico-printing machine, inking-rollers, etc. See DOCTOR.

Duc'tor-roll'er. (*Printing.*) A roller to conduct ink to another roller or cylinder.

Duf'fels. (*Fabric.*) A thick, coarse kind of woolen cloth having a thick nap or frieze.

Dug-out. A canoe formed of a single log hollowed out, or of parts of two logs thus hollowed out and afterwards joined together at the bottom and ends. See CANOE.

Dul'ci-an'a. (*Music.*) A metallic mouth-pipe stop tuned in unison with *diapason*, and having relatively long and narrow pipes which produce a certain sweetness of tone. See STOP.

Dul'ci-mer. The dulcimer is supposed to be identical with the psaltery of the Hebrews. It is frequently mentioned in Scripture. The modern *dulcimer* consists of a box with a cover which forms a sounding-board, and has a number of wire strings stretched over a bridge at each end. It is played by elastic rods with pellets of cork at the ends. The number of strings is usually about fifty.

"Here [at the puppet play in Covent Garden], among the fiddlers, I first saw a dulcimere played on with sticks knocking of the strings, and is very pretty." — PEPYS'S *Diary*, May 24, 1662.

"The Javanese *gambang* has wooden and brass bars of different lengths placed crosswise over a wooden trough. They are struck by small sticks with a ball of pith at the end." — BICKMORE'S *Travels in the Indian Archipelago.*

Du'ledge. The dowel-pins of the fellies of a gun-carriage wheel.

Dum. (*Mining.*) A frame of wood like the jambs of a door, set in loose ground in adits and places that are weak and liable to fall in or tumble down.

Dumb-bell. An exercising weight consisting of a handle with an oblate sphere at each end.

a is the ordinary dumb-bell.

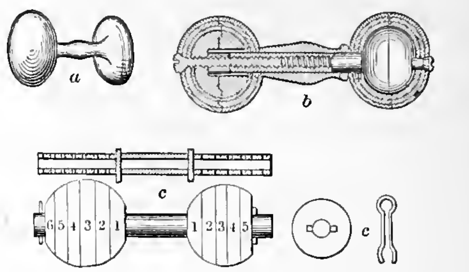
b is a dumb-bell in which the weight is graduated by constructing it of a series of shells, one over the other, which may be removed at pleasure.

c is Windship's dumb-bell, which has a number of weights slipping on a tube, and having washers and keys to hold firmly any number that may be desired.

The *halteres* of the Romans and Greeks were weights used for exercising and leaping. One was grasped in each hand and they were swayed to increase the momentum of the body when vaulting.

The *discus* was a circular stone or plate of metal, and was thrown from a fixed spot to a distance.

Fig. 1791.



Dumb-Bells.

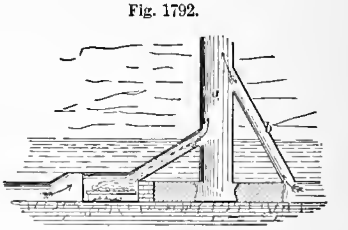
Our *quoits* are rings which are thrown on to or as near as possible to a stake, being a game of skill rather than of strength. In country places horseshoes are often used.

The Scotch game of "putting the stone," or throwing the hammer, resembles the hurling of the lump of iron in the funeral games of the Greeks. A heavy mass of a spherical form (*solos*) was perforated at the center to receive a thong or rope which formed the handle. In the form of the *discobolia* it is yet used by the mountaineers in the canton of Appenzell, in Switzerland.

In the Scotch game of *curling*, the stone or iron block is propelled along the ice to a stake or base, called the "pee," the object being to land it as near "home" as possible and dislodge opponents.

Dumb-fur'nace. A ventilating furnace for mines, so contrived that the foul inflammable air from the more remote parts of the mine shall not be brought in contact with the fire at the mouth of the up-cast shaft *a*. This is effected by causing the air from those parts to be introduced into the shaft by a separate passage *b* entering the shaft some distance above that from the furnace.

Fig. 1792.



Dumb-Furnace.

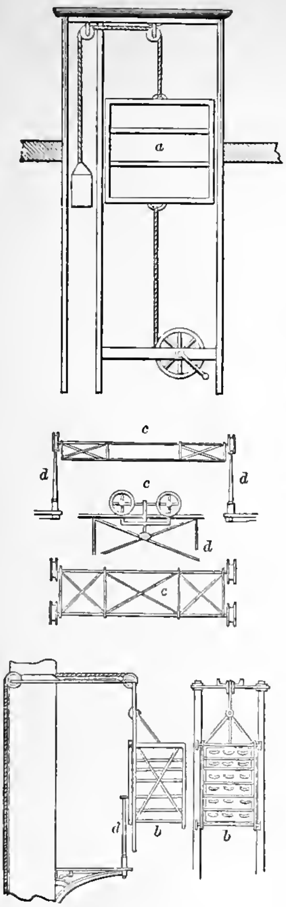
Dumb-plate. (*Steam.*) The *dead-plate* or portion of the furnace bottom close to the doors, which has no air apertures or spaces.

Dumb-wait'er. A movable frame for conveying food, etc., from one story or room of a building to another.

The ordinary form is a suspended, counterpoised cupboard *a*, moving within a vertical chute, which has openings at the respective stories, at which the dishes may be placed on the shelves and removed therefrom.

The dumb-waiter of the Pentonville Prison, England, consists of a cupboard *b* hoisted by means of a winch, and containing trays which are removed from the cupboard and placed on a carriage *c* which runs on the hand-railing *d* of the balconies on opposite sides of the corridor. This prison is conducted on the separate, silent system, and as the carriage trav-

Fig. 1793.



Dumb-Waiters.

erses along the corridor, attendants at each end stop the carriage opposite the doors of the cells in succession, and distribute the food to the inmates.

Dum'my. 1. A locomotive with condensing engines for city travel, and consequently avoiding the noise of escaping steam. See STREET-LOCOMOTIVE.

2. A floating barge connected with a pier.

3. (*Hat-making.*) A tool of box-wood, shaped like a smoothing-iron, and used by hat-makers in glossing the surface of silk hats.

Dum'my-car. A passenger-car having an engine and boiler in an end compartment.

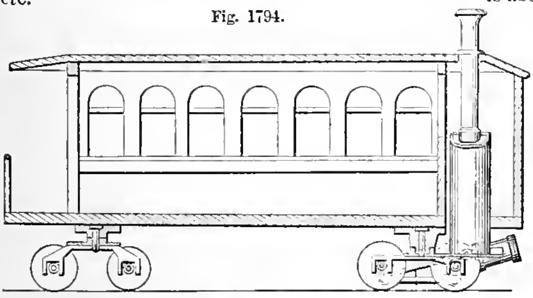
Dumb-sin'-gles. Silk thread formed of several spun filaments, associated and twisted together. Several *dumb-singles* combined and twisted together form *thrown-singles.*

Dump-bolt. (*Shipbuilding.*) A short bolt driven in to hold planks temporarily, until the through bolts are driven.

Dump'ing-buck'et. (*Mining.*) A hoisting-bucket in a shaft so swung as to be tipped for the discharge of its load, or having a bottom which is closed by a latch, but may be swung open for dropping the contents.

Dump'ing-car. Dumping-cars are used in constructing and ballasting railroads, excavating and filling in, canal and dock building, for carrying ores, etc.

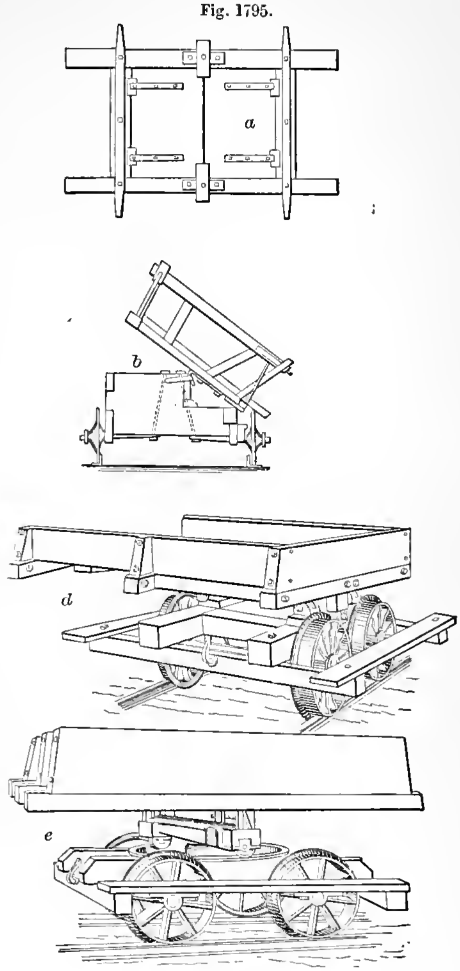
Fig. 1794.



Dummy-Car.

The car *a* has shutters in the bottom which are allowed to fall when a bolt or button is withdrawn. The tilting car *b* has a bed secured by a longitudinal bolt to the frame, and may be tilted sideways so as

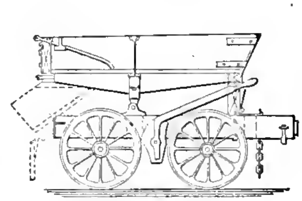
Fig. 1795.



Dumping-Cars.

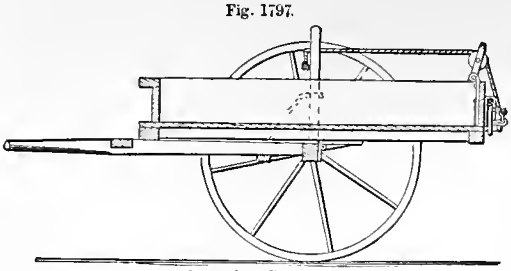
to discharge its load over the wheels outside the track. Hooks retain the bed in a level position till the car reaches the place to dump the gravel. Dumping-cars are made to discharge at end or side (*d*), or to swivel and dump in any direction (*e*). The load is about $2\frac{1}{2}$ cubic yards.

Fig. 1796.



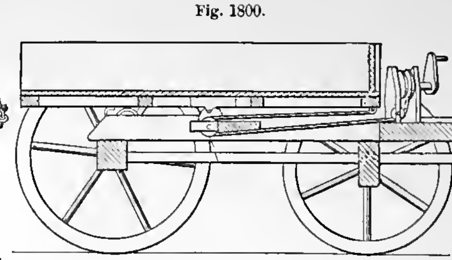
English Dumping-Car.

Fig. 1797.



Dumping-Cart.

Fig. 1800.



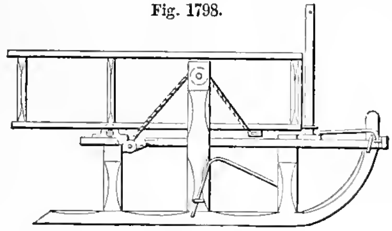
Gravel-Wagon.

Dump′ing-cart. One having a bed hinged to the axle and capable of being tipped to discharge its load. In the example, as the cart or wagon body is tipped up to dump the load, the tail-board will be raised automatically, and will drop back again into place and fasten itself as the said body is again raised into a horizontal position.

Dump′ing-reel. An arrangement in a harvester for dropping the gavels of grain. The cut grain falls against one of the reel-bars, which hold it up till a gavel is collected. The reel then makes a partial rotation, dropping what has been collected in the rear of the cutter-bar, and bringing another bar into position for collecting another gavel.

Dump′ing-sled. One with an arrangement for sliding back the bed so that it may overbalance and tip out the load. The box is hinged to the rear

Fig. 1798.

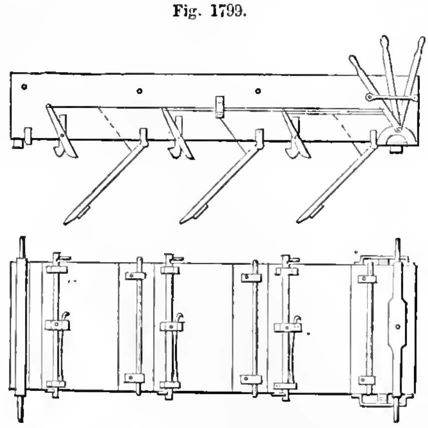


Dumping-Sled.

bolster so as to tip and dump the contents when the bed is run back. This is done by removing a catch, when the draft of the team on the tongue draws upon a rope and runs the box to the rear.

Dump′ing-wag′on. One with an arrangement for discharging the contents. In Fig. 1799 the hinged sections constituting the bottom may be

Fig. 1799.



Dumping-Wagon.

swung down to dump the load. Each section is independently held by a latch, and each latch may be operated by its appropriate lever at the right hand of the driver, so as to deposit the contents of the wagon-bed in three separate piles.

Fig. 1800 has a wagon-bed which runs back on rollers by power applied through a winch and ropes. By a change of the tackle the bed is replaced.

Dump′y-lev′el. Gravatt's level. A spirit-level having a short telescope with a large aperture, and a compass; used for surveying purposes.

The telescope is made of sufficient power to enable the surveyor to read the graduations on the staff without depending on an assistant.

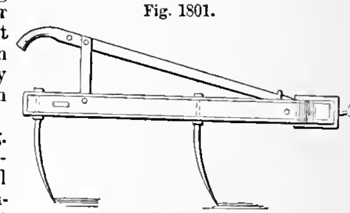
Dun′der. (*Sugar-making.*) The distillable lees and dregs of the cane-sugar boiling.

Dung-bath. Used in calico-printing works. See DUNGING.

Dung-fork. A 4-tined fork for pitching and spreading manure.

Dung-hook. (*Agriculture.*) An implement for dragging out manure or scattering that which has been previously dumped in heaps.

Fig. 1801.



Dung-Hook.

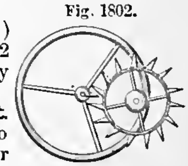
Dung′ing. (*Calico-printing.*) Removal of the superfluous mordant by passing dried calico through a warm mixture of cow-dung and water. It is passed through two cisterns 6 feet by 3 and 4 feet deep, the first of which has two gallons of dung to its contents of water, and the other a solution of half the strength. It is quickly passed through them in succession, washed in a *wince-pit*, and then in a *dash-wheel*.

A solution of phosphate of lime, phosphate of soda, and gelatine, is sometimes substituted for the cow-dung.

Dun′nage. (*Nautical.*) On shipboard, the name applied to loose wood at the bottom of a hold to raise the cargo above the bilge-water, and also to chock it and keep it from rolling when stowed.

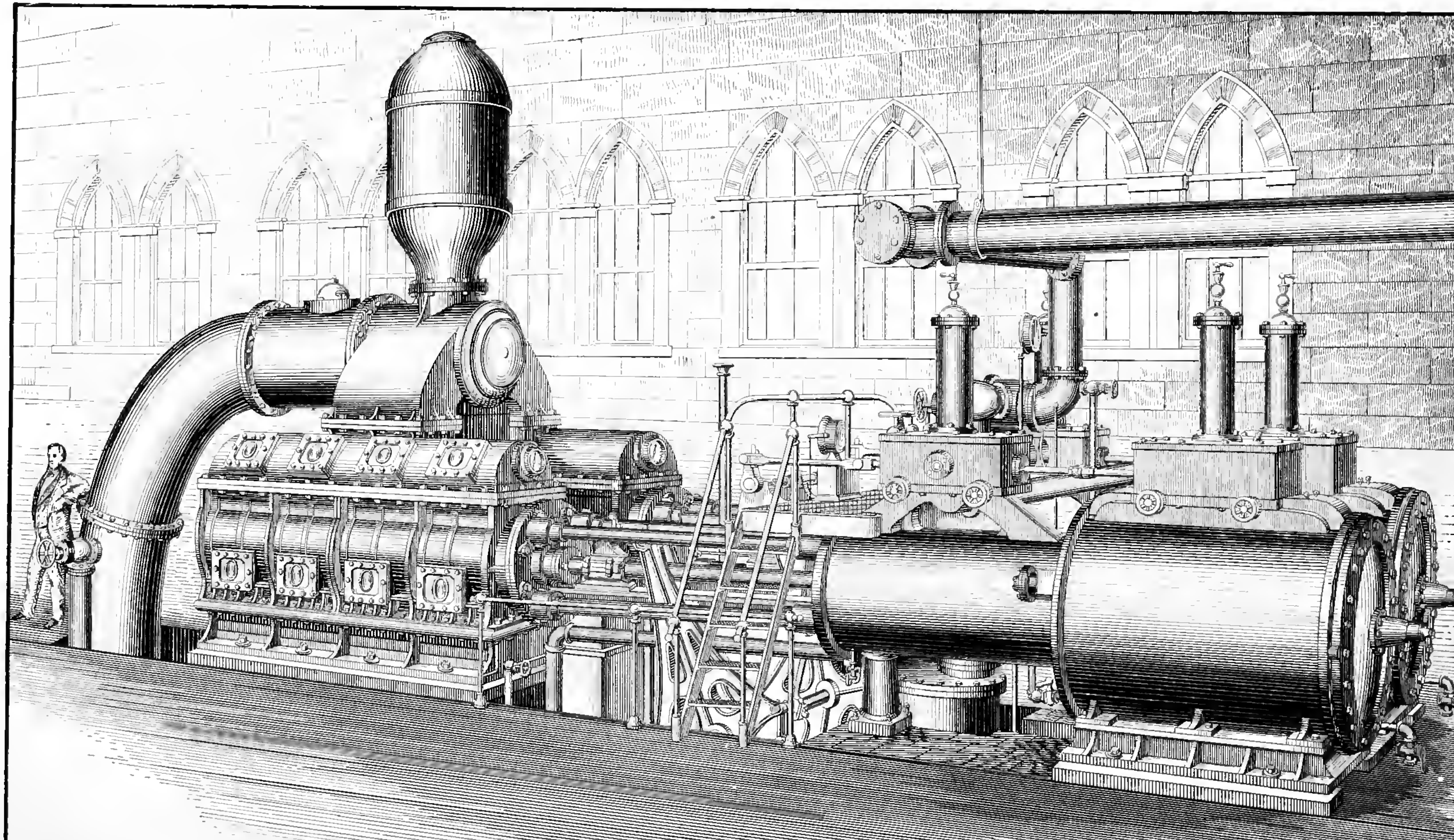
Du′o-dec′i-mo. (*Printing.*) A sheet folded so as to have 12 leaves, — 24 pages. Generally written "12mo."

Fig. 1802.



Duplex-Escapement.

Du′plex-es-cape′ment. The *duplex*-escapement is so called from the double character of its scape-wheel, which has *spur* and *crown* teeth. It was invented by that wonderful mechanician, Dr.



WORTHINGTON DUPLEX PUMPING-ENGINE.

PLATE XV

NEWARK, NEW JERSEY.

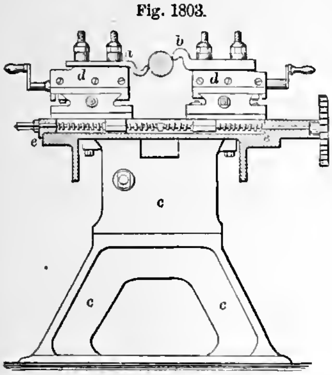
See page 763.

Hooke, about 1658. The duplex-escapement was improved by Dyrer and Breguet.

The *balance-arbor* carries a *pallet* which at each oscillation receives an impulse from the *crown-teeth*. In the *arbor* is a notch into which the *spur-teeth* fall in succession as the *crown-teeth* consecutively pass the *impulse-pallet*.

Du'plex-lathe. A lathe invented by Fairbairn for turning-off, screwing, and surfacing. The peculiarity in this lathe consists in the employment of a cutting-tool at the back of the lathe in addition and opposite to the tool in front, but in inverted positions to each other. The transverse forces are thus balanced, and time is saved.

Fig. 1803.



Fairbairn's Duplex-Lathe.

a, tool in front.

b, inverted tool at back.

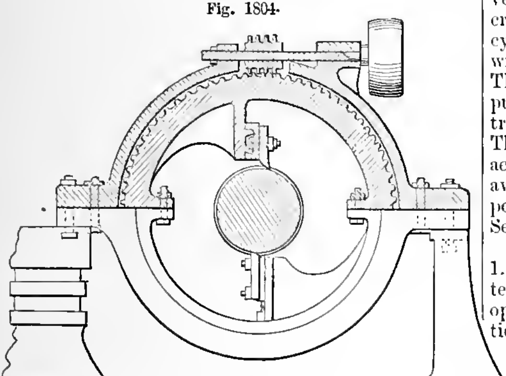
c, bed and standard.

d and *d*, two compound slide-rests.

e, a right and left screw for moving the two slide-rests simultaneously to and from the center of the lathe.

In another form the stationary ring is supported on pedestals, and fits closely to the outer surface of a ring within it, each being formed in two parts held together by bolts passing through projecting flanges. The inner ring has flanges projecting inward from its rim, upon which the cutters are arranged, and a continuous row of short cogs on the outer surface of the ring-gear, with a worm-wheel working in a mortise made through the outer ring.

Fig. 1804.



Bogardus's Duplex-Lathe.

Du'plex Pump'ing-en'gine. An arrangement in which two steam-engines of equal dimensions are placed side by side, one operating the steam-valves of the other.

The "Worthington" compound engine illustrated is composed of two steam-engines each working a pump. Each engine has two steam-pistons, which operate in the smaller high-pressure and the larger low-pressure cylinder respectively, on the same rod, which is prolonged into the pump-cylinder to form the pump-rod.

Each engine drives its plunger at a speed uniform throughout its stroke, during which it opens, by a rock-shaft and appropriate connections, the steam-valve of its neighbor, and pauses at the end of its own stroke till its own steam-valve, being opened by the motion of the other's piston-rod, causes it to return. Other than this, there is no mechanical connection between the engines, but either piston can remain at rest while the other is in motion.

The combined and reciprocal action of the two double-acting plungers thus driven at unvarying piston speed by the combined pressures in the high and low pressure steam-cylinders (whose sum is a practically uniform quantity) forces the water in a steady stream, and the water-valves are seated by their own. gravity through the equalization of pressures in the water-cylinder, during the pause of each engine at the end of its stroke, allowing the incoming currents to subside.

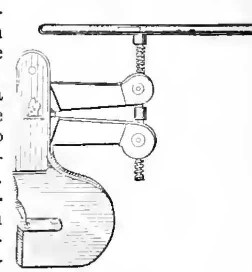
The engine works expansively, and also condenses the steam; but no cut-off is used, the steam being used at high pressure in the smaller cylinder and exhausting into the large low-pressure cylinder which is immediately behind and in line with it, and where it is used expansively. The motions are all reciprocating; no materials are employed for counterbalances, to pass dead-centers, or as conservators of power (fly-wheels) to offset by acquired momentum the diminishing pressure of steam in the cylinder when steam is cut off at a part of the stroke. The mean pressure resulting from the action of the two cylinders being almost constant when the parts are properly proportioned, the result is a uniform piston speed.

The single-acting air-pumps are driven by rock-shafts off the main piston-rod, and are in a convenient and accessible position below the open cradle-rods, which connect the steam and pump-cylinders. The valves are rubber disks, backed with iron, working vertically on fixed spindles. They are reached through the hand-holes, and are purposely made numerous in order to subdivide any trouble from the possible failure of any one of them. The duty trial of the Newark engine, reduced to the actual delivery of water in the reservoir, was by an average of the modes of calculation about 76,500,000 pounds lifted one foot high by 100 pounds of coal. See Duty.

Du'plex-punch. 1. One having a counter-die mounted on an opposite jaw, as the ticket-punch.

2. One having a force derived from the rolling action of two levers on a common fulcrum, forming a toggle.

Fig. 1805.



Duplex-Punch.

Du'plex-tel'e-graph. A telegraph so arranged that messages can be simultaneously transmitted in opposite directions on the same line-wire.

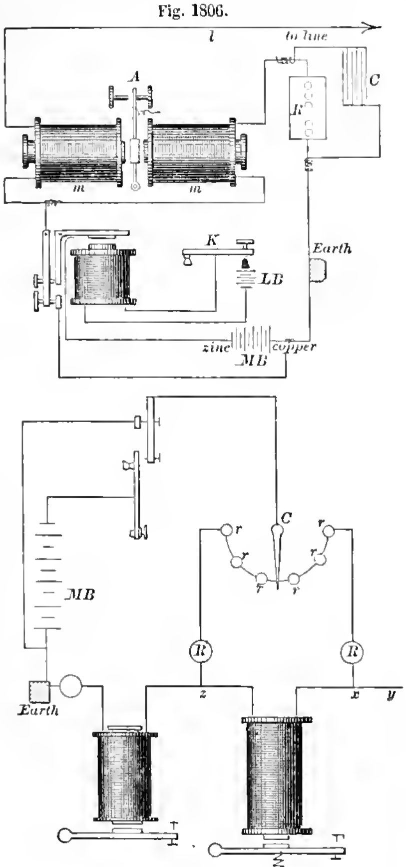
The first telegraph of this kind was devised by Dr. Gentl of Austria, in 1853, and modified by Frieschen and Siemens-Holske in 1854; but it is only within the past few years that any duplex systems have been put into successful operation, and, up to this time, only on American lines.

The system invented by Joseph B. Stearns, of

Boston, based upon Gentl's plan, is represented in Fig. 1806, in which the relay or receiving instrument is composed of two pairs of electro-magnets *m m* acting in opposite directions upon a common armature lever *A*. The key is the armature of an electro-magnet, which is in a local circuit controlled by a Morse key *K*. *L B* is the local battery. The main battery (*M B*) current is equally divided between the relay-magnets *m m*, one half passing through one set of magnets to the line *l*, and the other half passing through the other magnets, and a rheostat *R* — equal to the resistance of the main line — to earth *E*. The relay-magnets are thus equally excited and their influence upon the armature neutralized, so that the outgoing current gives no signal at the sending station. A current received, however, traverses only one set of the electro-magnets, destroying the equilibrium, and causing a signal. The key is so constructed that it closes one circuit to the earth before breaking another, thus always preserving the continuity of the circuit, a condition essential in systems of this kind. A condenser *C* is placed in a shunt circuit to the magnets in the short or home circuit, in order to neutralize the effect of the extra current on the line-magnets of the relay.

Another system of Mr. Stearns is shown in the

Fig. 1806.



Duplex-Telegraph.

lower part of the same figure. It is based on the arrangement of circuits known as the "Wheatstone bridge," the relay or receiving instrument being placed on the bridge. The current of the main battery is divided by the rheostats *r r* and *R R'* to points *x z*. If the resistances of circuits *C* to *z* and *C* to *x* are proportionately to each other as resistances of circuits *x y* or line, and *z* to earth, there will be no current in transmitting across the bridge *x z*, in which the relay or receiving instrument is placed. The larger portion of the incoming current, however, passes through and actuates the relay, as it offers the path of least resistance.

Moses G. Farmer, of Boston, invented a duplex system in 1858, in which he used a key which preserved the continuity of the circuit, and also reversed the battery at the sending station, this reversal making the signals at the distant station, the relay being prevented from responding by the current of a local equalizing battery closed simultaneously by this key.

Du′plex-type. (*Photography.*) A name given to a mode of taking two photographs of the same person in different positions by two operations, so that he shall appear in two characters — say, for instance, playing the piano, and — accompanying himself — on the violin. It is done by two exposures, with some skillful mode of hiding the division line. Shive's duplicating reflector is constructed for this purpose.

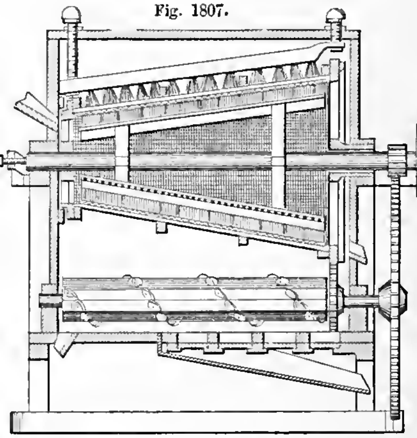
Du′rance. A stout woolen stuff formerly made in imitation of buff leather, and used for garments. *Durant.* Called also *Tammy.*

Du-rom′e-ter. An instrument invented by Behrens, designed for testing the relative hardness of steel rails. This "durometer," as it is styled, is virtually a small drilling-machine, working by hand or machine power, which registers the number of revolutions of the drill spindle and also the amount of feed, the latter being given by the application of a known weight to the back of the drill-spindle. The friction of the machine and the state of the cutting edges are supposed to be constant quantities, and as such are thrown out of the calculation. The hardness of a metal is considered to be inversely proportionate to the depth of feed obtained with a given number of revolutions.

Du-roy′. (*Fabric.*) A common quality of woolen serge.

Dust′er. 1. (*Paper.*) A machine for removing the dust from rags or other paper-making material

Fig. 1807.



Bran-Duster.

before sorting, cutting, and pulping. It consists of a revolving, wire-cloth cylinder inclosed in a box which receives the dust.

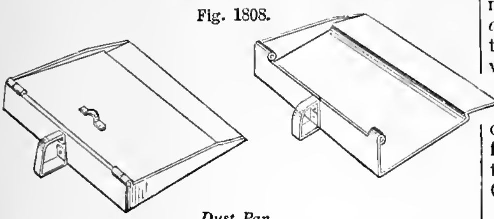
2. (*Milling.*) A machine for rubbing, brushing,

and blowing bran to remove particles of flour adhering thereto. The bran is fed in at a spout at the smaller end, and is driven and blown through the meshes of the conical screen.

Dust'ing-brush. One which has the thick end of the handle driven into the middle of the tuft of bristles. Or a feather brush.

Dust-pan. A domestic utensil for catching crumbs, lint, or dust, as they may be brushed from a table-cloth

Fig. 1808.



Dust-Pan.

or carpet. The example shown has a lid, handle, and an inclined plane with offset at the front edge.

Dust-shot. The smallest size of shot.

Dutch-case. (*Mining.*) A shaft-frame composed of four pieces of plank, used in shafts and galleries. A *mining-case.*

Dutch Clink'er. A yellow, hard brick made in Holland.

Dutch Foil. A copper alloy, rolled or hammered. See DUTCH GOLD, called also DUTCH LEAF; DUTCH METAL; DUTCH MINERAL.

Dutch Gold. The alloy used at the works of Hegermühl, near Potsdam, is composed of: —

Copper, 11; zinc, 2.

This is rolled into sheets, and is made into the Dutch leaf used in *bronzing.*

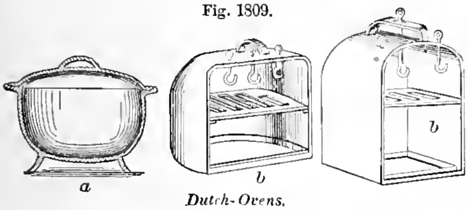
Dutch'ing. The process of removing the membraneous skin from the barrels of quills, and drying up the vascular membrane in the interior.

They are heated by plunging in hot sand, and then scraped to remove the skin. The heat shrivels the interior membrane and dissipates the oily matter of the quill, rendering it transparent.

Dutch'man. (*Carpentry.*) A playful name for a block or wedge of wood driven into a gap to hide the fault in a badly made joint.

Dutch-ov'en. (*Cooking.*) *a.* A *spider, skillet,* or *camp-oven* used by those who cook by hot coals on the hearth. A mode yet common in the West,

Fig. 1809.



Dutch-Ovens.

and unsurpassed in its results with skillful housewives. The pot stands in hot embers, and more of the same are piled on the dish-shaped lid.

b. A cooking-chamber suspended in front of a fire so as to cook by radiation. Also eminently satisfactory in its results, in just such degree as toasting exceeds baking; grilling or broiling than frying. It says, "Aha! I have *seen* the fire."

Dutch-scoop. A box shovel suspended by cords from a tripod and used for irrigation.

Dutch-tile. A variegated or painted glazed tile made in Holland and formerly used for lining their capacious fireplaces.

Dut'tees. Coarse, unbleached calicoes of India.

Du'ty. The useful effect of an engine in work performed.

This term was first explained in a definite and precise manner by Davies Gilbert, President of the Royal Society, in a paper read before that body in 1827. "The criterion of the efficiency of ordinary machines is force, multiplied by the space through which it acts; the effect which they produce, measured in the same way, has been denominated *duty*, a term first introduced by Mr. Watt in ascertaining the comparative merit of steam-engines, when he assumed one pound raised one foot high, for what has been called in other countries the dynamic unit; and by this criterion one bushel of coal has been found to perform a duty of thirty, forty, and even fifty millions." This has been more than doubled since the writing of the paper of Mr. Gilbert.

The duty is not an expression of the work done, as this would include the power to overcome friction and other resistances, but is the actual useful effect, expressed in pounds weight, of water actually raised.

The duty of the Newark water-work duplex-pumping engine, as obtained by multiplying together the area of the plunger in square inches (373.85), and the pressure in pounds per square inch (75.68), to obtain the load in pounds, and this by the travel of the piston in feet per hour (10,908.4), and dividing this product by the number of hundreds of pounds of coal consumed per hour (4), was 77,157,840 foot-pounds. As obtained by multiplying the displacement per stroke in cubic feet (10.4042), into the number of strokes per hour (2722), the weight in pounds of a cubic foot of water (62.5), and the height in feet to which the water was raised for delivery (174.82); and dividing this product by the number of hundreds of pounds of coal consumed per hour (4), the duty was 77,358,478. As reduced to the actual delivery of water in the reservoir, it was 76,386,262 and 76,584,894 by the two methods respectively.

The following is the duty officially given for the engines cited: —

Brooklyn, No. 1, double-acting beam .	60,140,700
Belleville (Jersey City), Cornish .	62,823,300
Hartford (3 experiments), crank	58,779,300 to 64,669,400
Brooklyn, No. 3, double-acting beam .	72,000,000
Cambridge (2 experiments), Worthington double-cylinder, not duplex	66,941,100 to 67,574,600
Spring Garden (Philadelphia), Cornish	58,905,300

The *duty* or useful effect of the Cornish pumping-engine has been more closely observed and recorded than that of any other engine. The *duty* is reported monthly, and is reduced to tabulated form, from which the yearly report is made out.

The duty of these engines has been gradually improved. It is estimated by the number of pounds raised one foot high by a bushel of Welsh coals, 94 pounds.

	Pounds, 1 foot high.
In 1769, the Newcomen engine . .	5,500,000
In 1772, the Newcomen engine, improved by Smeaton . . .	9,500,000
In 1778 to 1815, the Watt engine .	20,000,000
In 1820, the improved Cornish engine, average duty	28,000,000
In 1826, the improved Cornish engine, average duty	30,000,000

	Pounds, 1 foot high.
In 1827, the improved Cornish engine, average duty	32,000,000
In 1828, the improved Cornish engine, average duty	37,000,000
In 1829, the improved Cornish engine, average duty	41,000,000
In 1830, the improved Cornish engine, average duty	43,350,000
In 1839, the improved Cornish engine, average duty	54,000,000
In 1850, the improved Cornish engine, average duty	60,000,000
Consolidated mines, highest duty 1827	67,000,000
Fowey Consols (Cornwall), highest duty 1834	97,000,000
United mines, highest duty 1842	108,000,000

D-valve. A species of slide-valve, employed chiefly in the steam-engine, and adapted to bring each steam-port alternately in communication with the steam and exhaust respectively.

Dwang. 1. A large iron bar-wrench used to tighten nuts on bolts.

2. A crow-bar used by masons.

Dwarf-raft'er. (*Carpentry.*) Little jack. A short rafter in the hip of a roof.

Dwarf-wall. A low wall serving to surround an inclosure; such a wall as that on which iron-railing is commonly set.

Dye'ing. Dyeing is a subject not involving much machinery, and is therefore hardly within our limits.

Dyes are organic and inorganic.

The former are vegetable, except cochineal, sepia, and the purple of the murex.

Most of the vegetable colors do not exist naturally in plants, but are obtained by subjecting vegetable substances to special chemical treatment; as in the case of *garancine*, obtained from madder.

The art of dyeing consists in impregnating fiber, in the state of cloth or otherwise, with coloring substances.

Fibrous materials differ in their relative disposition to *take* color. Their disposition to absorb and retain color is in the following order, beginning with the one which has the greatest attraction for color: —

Wool. Flax.
Silk. Hemp.
Cotton.

Woolen goods dyed before weaving are called *wool-dyed;* if after weaving, *piece-dyed.*

Dye-colors are *substantive* or *adjective.*

The former act directly, imparting their tints by simple immersion in their infusions or decoctions; the latter intermediately, and are the more numerous, requiring *fixing* or *striking.*

The intermediate substances are called *mordants.* The mordant is first applied, and causes the dye which follows to adhere to the fiber, often singularly affecting its tint. Thus: cotton dipped in a solution of copperas (*mordant*) and then in a solution of logwood (*dye*) becomes black. If a solution of tin (*mordant*) be substituted for the salt of iron, the tint imparted by the logwood will be violet. Mordants were used in China and India from very distant periods, and are described by Pliny. See Calico-printing.

Moses (1490 B. C.) speaks of stuff dyed "blue, purple, and scarlet"; "rams'-skins dyed red."

Joseph (1729 B. C.) had a coat of many colors; probably a product of Damascus.

Dyeing is attributed to the Phœnicians. Solomon (1000 B. C.) sent to Hiram of Tyre for a man "cunning to work in . . . purple and crimson and blue." Ezekiel speaks, in his burden of Tyre, of the "blue and purple from the isles of Elisha," which may mean the Peloponnesus and adjacent islands.

The most celebrated dye of antiquity was the Tyrian purple, derived from a species of murex. Pliny cites two, the *buccinum* and *purpura.* A single drop of fluid was obtained from a sac in the throat of each animal. A quantity was heated with sea-salt, ripened by exposure for three days, diluted with five times its bulk of water, kept warm for six days, being occasionally skimmed; then clarified and applied as a dye to white wool previously prepared by the action of lime-water or fucus. The wool was first plunged into the *purpura* and then into the *buccinum.* Sometimes a preliminary tint was given with coccus (kermes). The dye and dyed goods are celebrated in the Hebrew and other ancient scriptures.

This color seems, from its extreme beauty, permanence, and costliness, to have become regal, and the royal taste is for the same down to our day. The color of the velvet in the crown of the Queen of England is a shade of purple; the velvet coronation robes of George IV. were of that color. Pliny (A. D. 70) says that the robes of triumph in the time of Homer (900 B. C.) were colored. Purple habits were given to Gideon by the Israelites from the spoils of the kings of Midian. Achan secreted a Babylonish garment, and suffered for it. Plutarch says that when Alexander took Susa, the Greeks took from the royal treasury purple stuffs to the value of 5,000 talents (1 talent $860 × 5,000 = $4,300,000), which still retained their beauty, though they had lain there 190 years.

Prussian blue was discovered by Diesbach, at Berlin, 1710; aniline, in 1826, by Unverdorben. In 1856, Perkin, experimenting with aniline, treated it with bichromate of potassa, and obtained *mauve.* Arsenic tried as a substitute for bichromate of potassa produced *magenta;* blue, green, violet, and other colors were subsequently produced.

(*Hat-making.*) Hats (black) are dyed in a solution of sulphate of iron, verdigris, and logwood, at a temperature of 180° F. They are alternately dipped and aired, the process being repeated perhaps a dozen times. The hats are all on thin blocks, and a *suit* of five dozen fills a crate, which is swung from a crane, and thus raised and lowered as required.

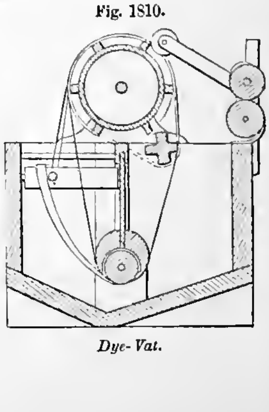
Dye-ket'tle. (*Hat-making.*) The vat of dyeing liquid in which hats are dipped to color them. It contains a solution of sulphate of iron, verdigris, and logwood, is maintained at 180° F., and the crate of hats on their blocks is repeatedly dipped and aired to confer the requisite depth and gloss of color.

Dy'ers'-bath. The dyeing material in the vat in which the fabric is immersed.

Dy'ers' Spir'it. Nitro-muriate of tin. Employed as a mordant.

Dye-vat. A beck or tub in which goods in piece or otherwise are saturated with a dye or a mordant in solution. In Fig. 1810, the piece of cloth, its ends being sewed together and rounded in

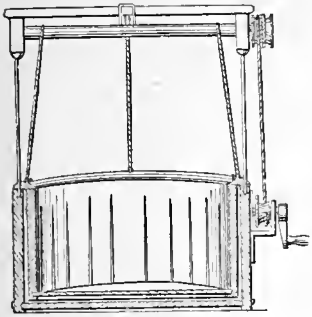
Fig. 1810.



Dye-Vat.

form, is coiled around the rollers in a devious course, so that the whole piece has continuous movement, in which it is alternately carried beneath and raised from the liquid dye. When the cloth has been sufficiently dipped the ends are unsewn, and the forward end is passed between the wringing rollers in a flat form.

Fig. 1811.

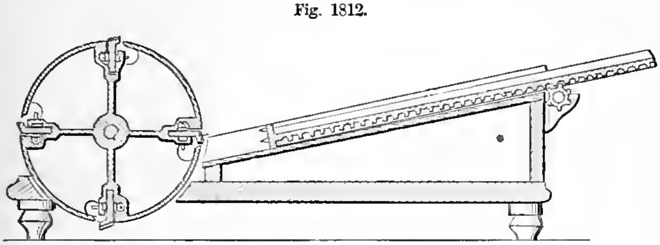


Dipping-Vat.

In another form, the goods are contained in a basket, which is dipped into the vat and raised by crank and rope.

Dye-wood Cut′ter. A machine for shaving wood into small chips; usually has a revolver-cutter, and resembles a rotary planer, except that it reduces the whole body of the log to chip. The rotating drum has adjustable serrated cutters. The wood is fed on an inclined slide, and propelled by a toothed follower, actuated by a spur-wheel and rack. See also Bark-planing Machine; Rossing-machine.

Fig. 1812.



Dye-Wood Cutter.

Dyke. 1. (*Mining.*) A bank of basalt or whin by which the strata or lodes are frequently divided.

2. A sea-wall. See Dike.

Dy-nac′ti-nom′e-ter. An instrument described by M. Claudet ("Philosophical Magazine," June, 1851), for measuring the intensity of the photogenic rays of light, and computing the power of object-glasses. See Actinometer.

Dy-nam′e-ter. An instrument for measuring the magnifying power of a telescope.

The magnifying power is the ratio of the solar focal distance of the object-glass to the focal distance of the eye-piece considered as a single lens; and this ratio being the same as the ratio of the diameter of the aperture of the telescope to the diameter of its image or disk formed at the solar focus, and seen through the eye-piece, the object of the instrument is to measure the exact diameter of this image, which can be either projected on mother-of-pearl or measured by optical means.

Ramsden proposed for this purpose the double-image micrometer, an instrument formed by dividing the eye-lens of a positive eye-piece into two equal parts, and mounting them so that the divided edges are made, by means of a fine screw apparatus, to slide along each other. Each semi-lens thus gives a separate image; and the distance of the two centers, measured by the revolutions of the screw, when the borders of the two images are brought exactly into contact, gives the distance of the centers of the images, or the diameter of one of them.

Dyn′a-mite. An explosive compound invented by Nobel. "It is a mixture of 75 per cent of nitro-glycerine with 25 per cent of infusorial silica. The silica renders the powder less liable to explode from concussion. This is the dynamite proper, but dynamite is also used as a generic name for other mixtures of nitro-glycerine,—as colonia powder, which is gunpowder with a mixture of 40 per cent of nitro-glycerine; dualine, which contains 30 to 40 per cent of nitro-glycerine mixed with sawdust saturated with nitrate of potassia; lithofracteur, which contains 35 per cent of nitro-glycerine mixed with silica, and a gunpowder made with nitrate of baryta and coal." —*Journal of Applied Chemistry.*

Dyn′a-mom′e-ter. A power measurer.

Graham's dynamometer, improved by Dr. Desaguliers, is an application of the ordinary steelyard, in which the power to be measured is exerted upon the short arm and ascertained by a weight on the longer, graduated arm.

Leroy's dynamometer is a spiral spring in a tube. Power is applied to condense the spring, and the pressure indicated by a graduated bar. This is equivalent to the ordinary spring-balance, and is a very ready form of dynamometer for moderate forces.

Regnier's dynamometer (1, Fig. 1813) consists of an elliptic spring whose collapse in the direction of its minor axis is made to move an index-finger on graduated arcs.

The power may be applied in two ways: when it is applied to draw the ends *s s* apart, the index-finger registers myriagrammes on the outer scale; but when the two leaves of the spring are grasped by the hands and thus pressed by a power applied at right angles to the former, and in the most effective direction, a shorter pin on the same pointer registers kilogrammes on the inner arc of graduations.

The graduated plate with its pointers belongs to one leaf of the spring, — the upper leaf in the illustration, — while the other leaf connects by a small copper lever with an arm which pushes the index-finger as the elliptical spring is collapsed by force applied to it. The index-finger moves freely and retains the attained position, being unaffected by the relaxation of the force.

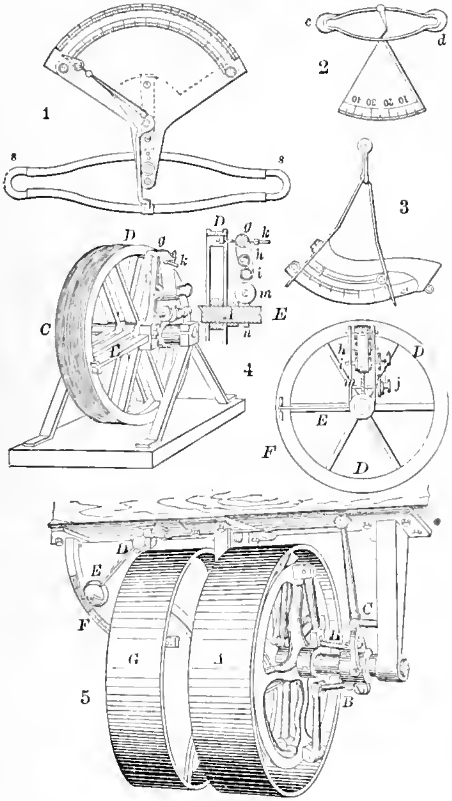
For moderate forces the power is applied to condense the spring by directly pressing the leaves together in the line of the minor axis. For superior forces the spring is collapsed by direct draft outward, upon the loops *s s* at the ends of the spring.

Braby's dynamometer (2, Fig. 1813) has an elliptic spring like Regnier's, but a somewhat different recording connection. Like Regnier's heavier draft, it is attached by the ends *c d*, between the power and the load, and the application of force collapses the leaves of the spring, oscillating the index-finger on its axis, and recording upon the graduated arc the amount of power exerted.

The Sector dynamometer (3, Fig. 1813) is made of a bar of steel, bent in the middle, and having a certain flexibility. To each limb is attached an arc which passes through a slot in the other limb. Loops at the ends of the arcs permit the device to be placed between the power and the load, so that the limbs are approached when power is applied. One arc is graduated so as to indicate the power exerted in bringing the limbs nearer together. The graduations made on the arc are in accordance with the result of the suspension of weights experimentally.

The above forms are specifically adapted for pulling forces, such as testing strengths of cords, power of animals, force required to draw plows, carriages, etc. When the problem is to ascertain the force transmitted through a revolving shaft, the case is somewhat more complicated. "A mechanical con-

Fig. 1813.



Dynamometers

trivance for measuring the force exerted by a prime mover, or the amount of force consumed in driving a machine or all the machines of an industrial establishment. It involves generally the expedient of interposing between the motor and the machine, as a medium through which the power is to be transmitted, some combination of springs, or some mechanism of which springs are the essential parts, provided with a scale on which are marked the degrees of static force corresponding to different states of tension, and sometimes also with automatic machinery for making periodical record of the marking of the index on the scale." — BARNARD.

Prony's friction-brake is a test which involves the loss of power, as it consists in opposing a frictional impediment to the motion. The measure is relative as compared with other machines similarly tested, and is determined by the power evinced to resist given frictional opposition to the continuance of the motion.

Thompson's friction-brake dynamometer has been contrived for estimating the amount of power transmitted through a shaft by means of clamping-blocks, a lever, and suspended weights. The requirement of a perfect dynamometer is that it shall not be itself a charge upon the power; that is, that by its interposition the expenditure of driving force required shall not be sensibly increased. This property belongs to all that class in which the power of the motor acts directly with all its force to produce flexure in springs, while the springs by their effort of recoil transmit it undiminished to the machine.

Taurine's dynamometer forms a section interposed between two lengths of a shaft in line. Two arms are attached to the part of the shaft on either side of this joint, in a radial direction; those on the same side being diametrically opposite to each other, while those of each pair are ninety degrees from those of the other. Stout springs in the form of circular quadrants connect the extremities of these arms on two opposed quarters of the circle, and the force of the motor is transmitted through these springs by a pushing effort. The effect is to bend the arches outward, and the degree of this bending is indicated by a spring which connects their middle points. The flexure of this spring is diminished, and in straightening it moves an index in the direction of the axis of rotation.

Bourdon's dynamometer depends upon the transmission of the power by means of slightly spiral gearing, the tendency of which is to give the arbor of the gear a longitudinal motion in its bearings. This motion is opposed by a spring, and the degree of compression of the spring is the measure of the power transmitted.

Horn's dynamometer acts upon the principle of the torsion of the connecting-shaft.

The dynamometer (4, Fig. 1813) used by the jury of Class V. (*machines for direct use*) in the International Exhibition, London, 1851, was the invention of Colonel Morin of France.

To the shaft *A* is secured a pulley *C*, and on the same shaft is a loose pulley *D* which has a spring bar *E* extending between cheeks on pulley *C*, which is the only connection between them. When a force is applied to *D* and a resistance to *C*, the spring *E* is flexed, and the degree of flexure is the measure of resistance. To measure the degree of bending of the spring a frame is attached to the boss of the spring *E* supporting a series of rollers *g h i* a fusee *j* and pencil-holder *k*. On the edge of the pulley *D* is another pencil-holder. When the dynamometer is to be used, a long ribbon of paper is wound on the roller *h*, and its outer end being carried over the roller *g* is made fast to *i*, which is driven by a string from the fusee *j*, which bears on its axis a wheel *m* gearing into one on the shaft *A*. Until resistance is applied to the wheel *C* the two pencils make a single line, but when the spring is flexed the lines of the pencils diverge, one pencil continuing to draw a straight line and the other tracing a line at a distance from the first, varying with the degree of flexure.

Emerson's lever-dynamometer (5, Fig. 1813) is also designed for measuring power in transmission. The pulley *A* is loose on the shaft, and receives the power. Its connection with the shaft is made by means of a wheel keyed to the shaft and connected to the pulley by certain levers which have connection *B C D* with a pendulous weight *E* which registers on a scale *F* the amount of power exerted upon *A* to produce the motion of the pulley *G*, which is fixed to the shaft and delivers the power.

For medical uses a dynamometer is made compressible in the hand.

Dyn'a-mo-met'ri-cal-brake. A form of DYNAMOMETER (which see).

E.

Ear. A small projection on an object, usually for support or attachment; as:—

1. The *ear* of a bucket or cooking-pot to which the bail is attached. The *ear* or *lug* of a sugar or salt boiling kettle by which it is supported on the walls of the furnace. The ear of a shell is imbedded in the metal, and serves for inserting the hooks by which the projectile is lifted.

2. (*Music.*) In the metallic mouth-pipe of an organ; one of the pair of soft metal plates at each end of the slit or mouth of the pipe, which may be bent more or less over the opening, to qualify the tone.

3. The *canon* of a bell, the part by which it is suspended.

4. (*Printing.*) A projection on the edge of the frisket; or one on the edge of the composing-rule.

5. The loop or ring on the ram of a pile-driver by which it is lifted.

6. One of the two projecting parts on the portions of an eccentric strap by which they are bolted together.

Ear, Ar'ti-fi'cial. An auricle having the shape of the natural ear, and worn as an ear-trumpet, to collect the waves of sound and conduct them by a tube to the *meatus auditorius.* Usually made of gutta-percha colored to resemble nature, and attached by clasps to the natural ear. See AURICLE.

Ear-brush. A toilet instrument for cleaning the ear. A bulb of sponge on a handle. An *aurilave.*

Ear-cor'net. A small auricle which is contained within the hollow of the outer ear and has a short tube to keep open the *meatus auditorius* in cases of contraction or the presence of polypi. An *ear-trumpet.*

E-lec'tro-mag-net'ic Bat'ter-y. One in which the current is generated in the voltaic battery, as distinguished from the *electric*, the *magneto-electric*, or the *thermal* battery.

Ear'ing. (*Nautical.*) The rope which lashes the upper corner of a sail to its yard.

The *reef-earings* are used to lash the ends of the reef-band to the yard.

Ear of Di'o-nys'i-us. An acoustic instrument named after the sound-conducting orifice in the roof of the dungeons where the old Sicilian tyrant kept his prisoners.

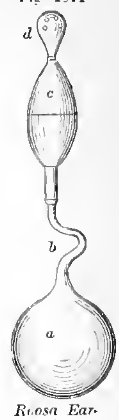
It has a large mouth-piece to collect the sound, which a flexible tube conducts to the ear of the person. It is especially adapted for enabling the very deaf to hear general conversation, lectures, sermons, etc. See ACOUSTIC INSTRUMENTS.

Ear-pick. (*Surgical.*) A small scoop to extract hardened cerumen from the *meatus auditorius*, or foreign matters from the external ear.

Ear-spec'u-lum. (*Surgical.*) An instrument for distending the exterior canal of the ear, in removing indurated wax, or other explorations and operations. An *otoscope.*

Ear-syr'inge. An instrument for injecting the ear with a liquid or medicated vapor. An ordinary syringe may answer the usual purposes of cleanliness, softening indurated wax, etc., but the instrument shown has a farther capacity. *a* is an india-rubber air-bag, *b* a flexible tube, *c* a bulb of hard-rubber, made in two pieces, which screw together and contain a sponge to hold chloroform or other liquid; *d* is the perforated bulb. It is particularly used in treating diseases of the middle ear. The sponge being previously moistened, the nozzle of the bulb is placed in one nostril, the other is closed by the finger of the surgeon, the mouth is also closed, and the patient, having previously taken a mouthful of water, is told to swallow, and, just as he is doing this, the surgeon compresses the air-bag, and sends the iodized air into the faucial orifice of the eustachian tube, and, if the drum be perforated, into the cavity of the tympanum.

Fig 1814



Roosa Ear-Syringe.

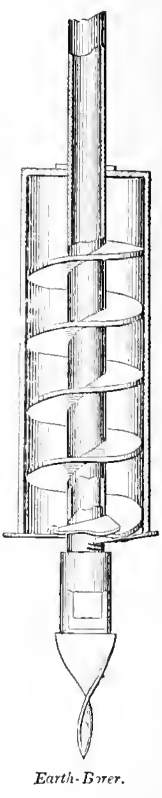
Earth. (*Telegraph.*) The ground in its relation to the circuit as the means of conducting the return current. The conductor is led to a buried ground-plate or to a gas or water main, which forms an admirable ground conductor.

Earth-bat'ter-y. A large plate of zinc and a plate of copper, or a quantity of coke, buried at a certain distance asunder in damp earth. The moisture of the earth acts as the exciting fluid on this voltaic couple, and a feeble but constant current is produced.

Earth-board. The mold-board of a plow.

Earth-bor'er. A form of auger for boring holes in the ground, where the strata are sufficiently soft and loose. The shaft has a screw-point and a cutting-face. The twisted shank revolves inside a cylindrical case, which retains the earth till the tool is withdrawn. The valve opens to admit the earth, and closes as the tool is lifted. See AUGER.

Fig 1815.



Earth-Borer.

Earth-car. A car for transporting gravel and stone in railway operations. See DUMPING-CAR.

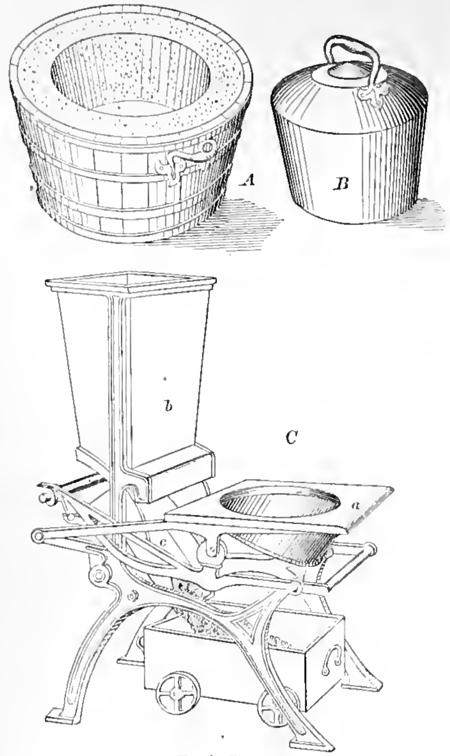
Earth-clos'et. A commode or night-stool in which a body of earth receives the feces, or is dropped upon them to absorb the effluvia; the resultant is to be utilized as a fertilizer.

A is a pan provided with an absorbent; when full, the lining and the contents are removed and buried, and another lining of earth placed in the pan by packing around the mold *B.*

C has a seat *a*, which descends with the person and brings a charge of earth in readiness to fall upon the feces. As the person rises, the quantity of earth released by the former operation is dropped upon the feces in the pan below. *b* is the earth reservoir, and *c* the dumping-spout.

Earth'en-pipe. The Romans used earthen pipes where economy was an object. They preferred lead. The earthen pipes had a thickness of at least two inches, and the ends were respectively contracted and enlarged to fit into and to receive the

Fig 1815.



Earth-Closets.

adjacent pipes. The joints of the pipes were lute l with quicklime and oil. The thickness was increased at the bottom of a bend, as in crossing a valley or hollow, or the pipe at this part was "secured by ligatures or a weight of ballast" (VITRUVIUS). Earthen pipes are found in the walls of the baths and the Coliseum, of various diameters, none less than 2 inches diameter. The elaborate arrangement of pipes in the amphitheater of Vespasian has probably never been excelled. Fifty-six drains constructed within the thickness of the walls which supported the staircases of the ground-floor served to carry off the rain-water which fell in the building, and also the contents of the urinals in the third and fourth stories. The drains were cylindrical pipes of 12 inches diameter, hollowed out of freestone blocks 20 inches in hight. The drains were led down from the upper stories through pipes in the masonry of the stairs, and united with hundreds of other drains at the larger conduits, which conducted the water to the Cloaca Maxima.

The arrangement of the aqueduct and distributing pipes which conducted the water from the fountain of Nismes was as elaborate as the emunctories described. See "Cresy," ed. 1865, pp. 108–118.

Earth'en-ware. A general expression which covers all ceramic work, such as stone-ware, delft, porcelain, etc. See POTTERY. The term, as far as it may have a less general meaning, includes merely the commoner classes of clay-ware, otherwise known as *crockery*.

The clay, having been properly tempered, is formed on the wheel and dried under cover until it has acquired considerable solidity. The glaze, of the consistence of cream, is then put on as evenly as possible by means of a brush. Small articles are glazed by pouring in the glaze and then pouring it out again, sufficient adhering for the purpose.

The glaze consists of galena ground to powder and mixed with "slip"; that is, a thin solution of clay. This is a clear glaze, and is made black and opaque by the addition of manganese: galena, 9; manganese, 1 part. The glaze having dried, the ware is piled in the kiln.

A low heat, applied for twenty-four hours, drives off the moisture; an increased heat for another twenty-four hours, as high as can be borne without fusion, bakes the clay, drives off the sulphur from the galena, and causes the lead to form a glass with the clay to which it adheres. With increase of heat this glass spreads over the surface of the ware. After the furnace is cooled, the ware is removed. The glaze, consisting of oxide of lead, is soluble in acids, such as vinegar and those of fruit, and is destroyed, rendering injurious the food with which it combines. A more refractory clay admits the use of a less fusible glaze of a harmless character.

Earthen-ware is found among almost all nations and tribes, though not all have the art of glazing, nor have all the art of baking. *Drying* is not *baking*, and it requires a good heat to make a good ringing article. The Egyptians and Etruscans had pottery at a date before the historic period. We know more of the former than of the latter at early periods. The resemblance of the Greek and Etrurian ceramic works is remarkable. Glazing came from China. Wedgwood's patents about 1762. See specific list under POTTERY AND CLAY.

Earth-plate. (*Telegraph.*) A plate buried in the earth, or a system of gas or water pipes utilized for the purpose, connected with the terminal or return wire at a station, so as to avail the earth itself as a part of the circuit, instead of using two wires, as was the practice previous to 1837.

Earth'quake-a-larm'. An alarm founded on the discovery or supposition that a few seconds previous to an earthquake the magnet temporarily loses its power. To an armature is attached a weight, so that upon the magnet becoming paralyzed the weight drops, and, striking a bell, gives the alarm.

Earth-ta'ble. The lowest visible course of stone or bricks in a wall or building.

Earth'work. An engineering term applied to cuttings and embankments.

Ear-trum'pet. An instrument for the collection and conduction of sounds. By increasing the size of the auricle, a larger volume of sound is gathered than by the natural ear.

The ear-trumpet for the assistance of the partially deaf is believed to have been invented by Baptista Porta about 1600. Kircher describes the funnel and tube for conveying sound, the device which is now so common for conveying intelligence between apartments and shops, in dwellings, warehouses, and factories.

Dr Arnott of England, who became partially deaf from a cold contracted in traveling, first devised the pair of shells or artificial ears which extend the surface displayed to gather the tremulous air.

There are two qualities required in a speaking-tube: that it shall concentrate a large amount of sound in a small space; and, secondly, that it shall not stifle the sounds within the tube itself. Gutta-percha seems to answer the latter conditions better than any other material.

The ear-trumpets are of several descriptions: —

1. The *long ear-trumpet a*, with a wide opening at the sound-reception end, and a small opening at

the delivery end. This is made portable and compact by bending. *b* has a rotatable section; *c* is a shorter trumpet; *d d* cane trumpets; *e* a short one.

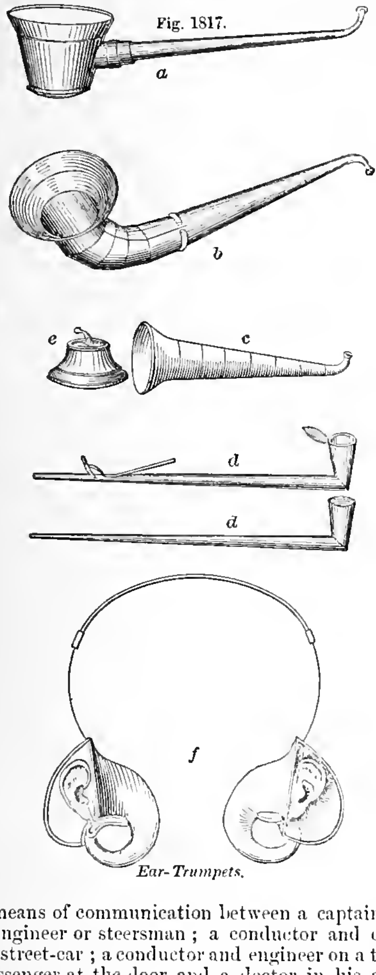
2. The ear-cornet *f* is a small and neat affair, adapted to be worn on the head.

3. The *paraboloid trumpet*, in which the sound is echoed from a large concave receiver before it enters the tube.

4. The auditorium trumpet, which is adapted to collect the sound of a speaker's voice and convey it to one or more parts of the room where the partially deaf persons may be sitting.

The uses of the acoustic tubes are various, forming means of communication between a captain and his engineer or steersman; a conductor and driver on a street-car; a conductor and engineer on a train; a messenger at the door and a doctor in his apartment; a housekeeper with the kitchen; an office with a factory; an editor with the compositor's room; a hospital office and the wards, etc.

Fig. 1817.



Ear-Trumpets.

In the auricle *f* the tube of the ear-trumpet near where it enters the ear is intersected by a passage communicating with an artificial ear which is intended to lead such vibrations as fall on it to unite with the vibrations passing round through the tube.

A *sonifer* is a bell-shaped instrument of metal placed on a table with the mouth turned in the direction whence the sound proceeds; the sound collected in the bottom of the instrument is conducted by a flexible tube to the ear of the person.

(*Microcoustic.*) An instrument to assist the hearing.

Eas'el. A wooden frame for supporting a picture during its execution.

Fig. 1818.

Easel.

Eave. The lower edge of a roof overhanging the wall.

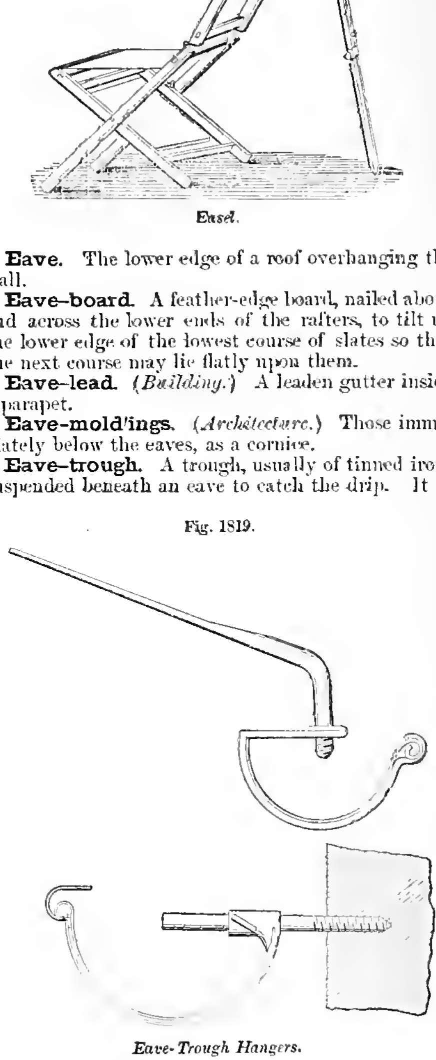
Eave-board. A feather-edge board, nailed above and across the lower ends of the rafters, to tilt up the lower edge of the lowest course of slates so that the next course may lie flatly upon them.

Eave-lead. (*Building.*) A leaden gutter inside a parapet.

Eave-mold'ings. (*Architecture.*) Those immediately below the eaves, as a cornice.

Eave-trough. A trough, usually of tinned iron, suspended beneath an eave to catch the drip. It is held by a strap or hanger, which may have means for the vertical adjustment of the trough, so as to give it the required fall in the length of the eave.

Fig. 1819.



Eave-Trough Hangers.

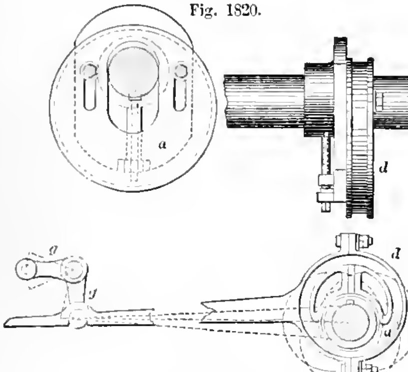
Eb'on-ite. Mr. Goodyear's name for what is generally known as hard rubber. It is a vulcanite with a larger proportion of sulphur and certain added ingredients. The proportion of sulphur is from thirty to sixty per cent, and to this may be added certain amounts of shellac, gutta-percha, chalk, pipe-clay, sulphates of zinc, antimony, or copper. It is used of many colors, as may be gathered from the above list of ingredients, and of hardness and consequent facility for taking polish. The compound, manger its name, may resemble horn, ivory, bone, wood, etc.

E-bul'li-o-scope. An instrument for determining the strength of a liquid by ascertaining its boiling-point.

Ec'cal-e-o'bi-on. A chamber for hatching eggs by artificial heat. See INCUBATOR.

Ec-cen'tric. A disk or wheel *a* fixed upon a shaft at some distance from its geometric center. Around it is placed a ring *d*, within which it is at liberty to turn; the ring, however, does not turn,

Fig. 1820.



Eccentrics.

but rotates around the axis of *a*, so as at its quarterly points to occupy the places indicated by the dotted circles, the effect of which is to rock the bell-crank lever *g g*.

The upper portion of the figure shows a shiftable eccentric for varying the throw.

The *fore eccentric* and *back eccentric* impart forward and backward motions respectively to the valve-gear and the engine.

The eccentric is used in many other machines besides steam-engines, to convert a rotary to a reciprocating motion.

Ec-cen'tric-catch. See ECCENTRIC-HOOK.

Ec-cen'tric-chuck. A chuck attached to the mandrel of a lathe, and having a sliding piece which carries the *center*. This piece is adjustable in a plane at right angles to the axis of motion by means of a set screw, and carries the center to one side of the axis of motion. By its means circular lines of varying size and eccentricity may be produced. No oval or ellipse is produced thereby, but circles on the face of the work with their centers at such distance from the axis of the mandrel as may be desired.

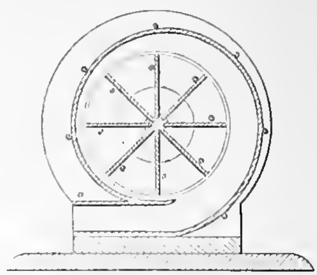
Ec-cen'tric-cut'ter. A cutting-tool placed upon the slide-rest, and having a rotation by means of a wheel and shaft, the cutter being attached to the end of the latter. The rotation is obtained by an *overhead motion*, and the eccentricity by fixing the cutter at different distances from the center by means of the groove and screw. The action of the eccentric-cutter differs from that of the eccentric-chuck in this: in the latter the work is rotated and the tool is stationary; in the former the work is stationary and the tool revolves.

When the motions are used in conjunction, the patterns are capable of almost unlimited variation.

Ec-cen'tric-en-grav'ing. An arrangement of diamond tracers, operated by elaborate machinery, acting upon a varnished roller designed for calico-printing. The effect is analogous to that produced by the rose-engine lathe.

Ec-cen'tric-fan. A fan-wheel with radial arms and vanes, and having an axis which is eccentric with the case in which it revolves. The case has a scroll form, and the effect is to make the discharge of air more perfect and avoid carrying a body of air around between the vanes.

Fig 1821.

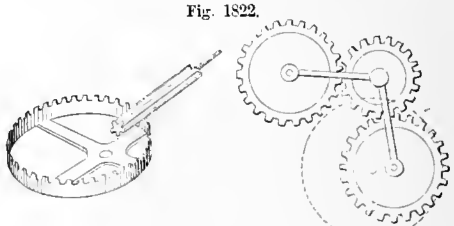


Eccentric-Fan.

Ec-cen'tric-gab. See ECCENTRIC-HOOK.

Ec-cen'tric-gear'ing. Cog-wheels set on eccentric axes give a variable circular motion, as in the case of the eccentric *contrate wheel* and pinion, and the eccentric spur-wheel and intermediate shifting pinion. Links connect the axis of the pinion with those of the *driver* and *driven* wheels, and preserve the pinion at proper mashing distance,

Fig. 1822.



Eccentric-Gears.

so as to engage with the *motor* and communicate the motion to the next wheel in series.

Ec-cen'tric-hook. (*Steam-engine.*) One used to connect the eccentric-rod with the wrist on the lever of the rock-shaft which actuates the valve; otherwise called a *gab*.

Ec-cen'tric-hoop. The strap on the eccentric of an engine.

Ec-cen'tric-pump. A hollow cylinder in which is a revolving hub and axis eccentrically arranged. On the hub are flaps which act as pistons in the space between the hub and the case to expel the water, which enters at one opening and departs by another. The same construction is seen in rotary steam-engines, only that in one case the shaft revolves to force water, and in the other the steam passes through to drive the shaft.

Ec-cen'tric-rod. The rod connecting the eccentric strap to the lever which moves the slide-valve.

Ec-cen'tric-strap. (*Machinery.*) The ring inclosing an eccentric sheave and connecting by a rod to the object to be reciprocated; as, the slide-valve of a steam-engine. See ECCENTRIC.

Ec-cen'tric-wheel. A cam consisting of a circular disk attached eccentrically to a shaft. It is used for communicating a reciprocating motion to the valve of a steam-engine. Its axis of revolution is out of the center of its figure, and the rectilinear motion imparted is called the *throw*.

The ring around the eccentric is the *eccentric-strap*.

The rod connecting the strap to the part to be actuated is the *eccentric-rod.*

The hook at the end of the rod, by which it is connected to the rock-shaft of the valve motion, is the *eccentric hook* or *gab.*

The whole apparatus is the *eccentric-gear.* See ECCENTRIC.

Ec-cop′e-us. (*Surgical.*) A surgeon's knife.

A *raspatory ;* an ancient instrument for trepanning.

E-chi′nus. A member of the Doric capital ; so called from its resemblance to the echinus, or large vase, in which drinking-cups were washed.

E-chom′e-ter. (*Music.*) A scale or rule marked with lines which serve to indicate the duration of sounds, and to ascertain their intervals and ratios.

E-clipse′-speed′er. (*Cotton,* etc.) A form of spinning-machine.

E′coute. (*Fortification.*) A gallery built in front of the glacis of a fortification, as a lodgment for troops to intercept the miners of an attacking force.

Ec-pho′ra. The projection of any member or molding before the face of the member or molding next below it.

E-cra′seur. A steel chain tightened by a screw, and used for removing piles, polypi, malignant growths, etc. Used also in obstetrical practice.

Fig 1823

Ecraseur.

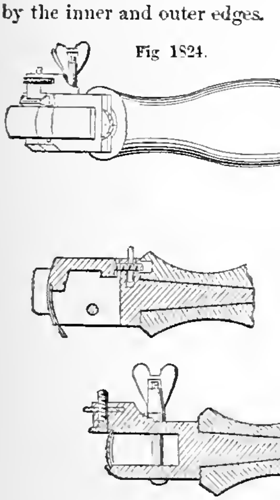
Ec-ty-pog′ra-phy. A mode of etching which gives the design in relief. The plate is exposed by the etching-needle between the lines, instead of at the lines.

Edge-cut′ting. The process of giving a smooth edge to books by cutting off the folds and making the margins of all the pages equal. The book is held in a *cutting-press* and the work done by a *plow* or *trimming-machine.*

Edge-joint. (*Carpentry.*) A joint formed by two edges, forming a corner.

Edge-mill. An ore-grinding or oil-mill in which the stones travel on their edges. In addition to the crushing action, the *edge-mill* has a frictional or grinding action, whose relative value may be considered as equal to the difference of distance performed by the inner and outer edges. See CHILIAN-MILL.

Fig 1824.



Edge-Plane for Shoe Soles.

Edge-plane. 1. (*Wood-working.*) A plane for edging boards, having a fence, and a face with the required shape ; flat, hollow, or round.

2. (*Shoe-making.*) A plane for shaving the edges of boot and shoe soles. It has a knife curved to the shape desired, a projecting edge which forms a guide and gage, and means for adjustment. The mouthpiece is adjustable, and holds the curved paring-knife by means of its jaws and set-screw.

Edg′er. A circular saw or pair of circular saws by which the bark and "*waney*" portions are ripped from slab-boards or boards made by ripping logs through and through, without squaring.

A double-edger has one permanent saw and one capable of regulation as to distance from the former one, so as to adapt the pair of saws to edge boards of varying width.

Edge-rail. (*Railroad.*) *a.* One form of railroad-rail, which bears the rolling stock on its edge. The rail is contradistinguished by its name from the *flat-rail,* which was first used ; the *angle-rail,* which succeeded that ; the *bridge-rail,* which presents an arched tread and has lateral flanged feet ; the *foot-rail,* which has a tread like the *edge-rail,* but, unlike it, has a broad base formed by foot flanges.

The first public railway laid with edge rails was made by Jessop of Loughborough, England, 1789. They were of cast-iron in 3 or 4 feet lengths, and had vertical holes near each end by which they were wooden-pinned to the sleepers. They were fish-bellied, and subsequently laid on cast-iron chairs.

Wyatt's patent in 1800 was an oval cast-iron rail. The upper surface was afterwards flattened.

Rolled-iron *edge-rails* were made in 1820 under Birkenshaw's patent.

See RAIL ; RAILWAY.

b. A rail placed by the side of the main rail at a switch to prevent the train from running off the track when the direction is changed.

Edge-roll. (*Bookbinding.*) A brass wheel, used hot, in running an edge ornament on a book cover, either gold or blind.

Edge-shot. A board with its edge planed is said to be *edge-shot.*

Edge-tool. (*Hardware.*) A general name which includes the heavier descriptions of cutting-tools, — axes, adzes, chisels, gouges, plane-bits.

Other cutting-tools come within the province of the armorer or cutler, and are included under *cutlery,* — knives, scissors, shears, surgical instruments, and, by the analogy of associated use, forks. See ADZE ; AXE ; HATCHET ; KNIFE.

The making of swords was anciently the work of the armorer, but has probably merged into *cutlery.*

Wood-cutting tools are divided by Holtzapffel as follows : —

1. *Paring* or *splitting* tools, with thin edges, the angle of the basil not exceeding 60° with the straight face. This includes *broad-axes, chisels, gouges,* etc.

Double-basil tools, such as *axes.*

2. *Scraping-tools* with thick edges, the angles measuring from 60° to 120°. These remove the fibers in the form of dust. The *veneer-scraper* is an instance. One angle of the edge of the steel plate is turned over to form a *bur,* known as a *wire-edge.*

3. *Shearing-tools ;* such are usually in pairs, acting from opposite sides of the object, the basil and face having an angle of from 60° to 90°.

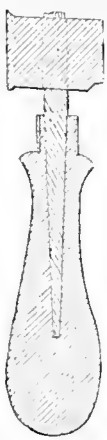
Iron and steel for edge-tools have been combined in a fagot and rolled so as to have a thickness of steel between layers of iron, for chopping-axes and some other tools, and with a layer of steel on one side for broadaxes, chisels, etc., which have but one basil. (Bonydell's patent, English.)

4. A burnisher for rubbing the edges of boot and shoe soles. See also EDGE-PLANE.

5. (*Saddlery.*) A tool used for removing the angular edge from a leathern strap.

For chamfering down the edges of a strap more broadly, another tool is used having a blade and

Fig 1825.



Edge-Tool.

guides which travel along the edge and face respectively of the leather. See CHAMFERING-TOOL.

Edge-wheel. A wheel traveling on its edge in a circular or annular bed, as in the ancient Phœnician oil-mills, the Chilian ore-mills, and many other crushing-mills. See CHILIAN MILL.

Edg'ing. The ornamentation of book edges by —

1. Color sprinkling.
2. MARBLING (which see).
3. Gilding.
4. Coloring ; as the rubric style now so common.

Edg'ing-ma-chine'. A machine for edging boards to a given pattern. An *edger*.

Edg'ing-shears. A gardener's shears for trimming the edges of sod around walks or beds.

Edg'ing-tile. Tiles for borders of garden-beds, in place of grown edgings, such as box, thrift, etc. Such tiles for pleasure-gardens are made ornamental ; for kitchen-gardens, plainer.

E-duc'tion-pipe. (*Steam-engine.*) The pipe which carries off the exhaust steam from the cylinder.

E-duc'tion-port. One through which the steam passes from the valves to the condenser. *Exhaust-port.*

E-dul'co-ra'tion. The effusion of water on any substance for the purpose of removing the portion soluble in that liquid. The article is usually agitated in water, which is removed by decantation after subsidence of the heavier portion.

E-dul'co-ra'tor. A dropping-tube for applying small quantities of sweet solutions to a mixture.

Ef-fect'. The amount of work performed by a steam-engine or other machine. See DUTY.

Egg-as-sort'er. A device by which eggs are assorted according to quality ; being so placed that a strong light is brought upon them when stuck into holes in a board, their comparative translucency is observed, and is accepted as an evidence of quality.

Egg-bas'ket. One for standing eggs in to boil, and also to hold them when placed on the table.

Fig. 1826.

Egg-Basket.

Egg-beat'er. A whip of wires or a set of wire loops rotated by gear while plunged in the egg contained in a bowl.

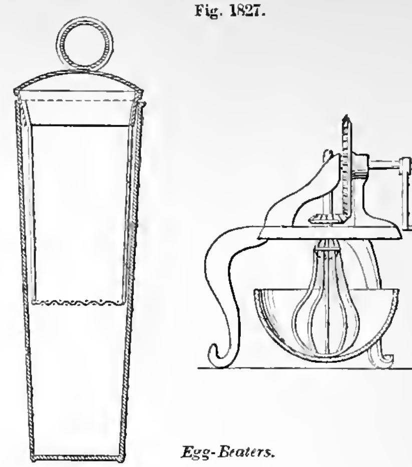
Another form is a vessel contained in another, and a wire gauze diaphragm through which the eggs pass when the vessels are reciprocated.

Egg-boil'er. A domestic device which sounds an alarm when the eggs have been exposed to the water a sufficient length of time to expand the water in the lower reservoir, raise the plug *d*, and release the trigger of the spring bell-hammer.

Egg-car'ri-er. A means for holding eggs in the proper carrying position without jolting against each other during transportation. The frames have cloth pockets for the eggs. In other forms the eggs are supported by pockets of wire or netting.

Egg-de-tect'or. An apparatus for showing the

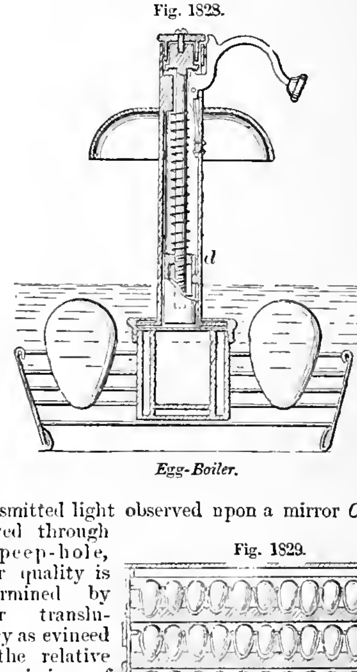
Fig. 1827.



Egg-Beaters.

quality of eggs. They are placed upright in the holes in the lid of the dark chamber, and their

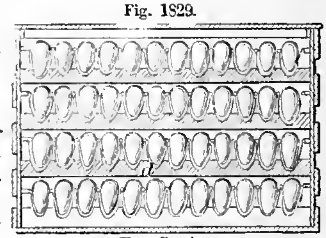
Fig. 1828.



Egg-Boiler.

transmitted light observed upon a mirror *C*; being viewed through a peep-hole, their quality is determined by their translucency as evinced by the relative transmission of light, as an egg becomes more cloudy and opaque as it becomes spoiled.

Fig. 1829.



Egg-Carrier.

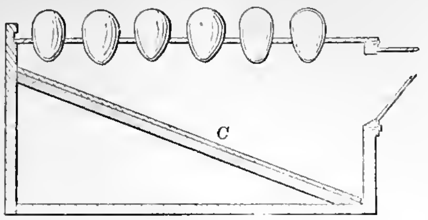
Egg-glass. 1. A glass for holding an egg while eating it.

2. A sand-glass running about three minutes, as a timist for egg-boiling.

Egg-hatch'ing Ap'pa-ra'tus. An apparatus for the artificial hatching of eggs. It has been practiced from time immemorial in Egypt. See INCUBATOR ; CALORIFERE.

Egg-mold'ing ; Egg and Tongue. (*Architecture.*) A peculiar molding in which a tongue de-

Fig 1830.



Egg-Detector.

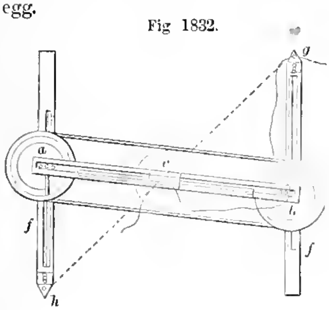
pendent from the corona alternates with an oval boss whose major diameter is vertical, like an egg set on end.

Egg-tongs. A grasping implement for seizing and holding an egg.

Fig. 1831.

Egg-Tongs

Fig 1832.



Eidograph.

Ei′do-graph. An instrument for copying drawing, invented by Professor Wallace. It consists of a central beam of mahogany, sliding backward and forward in a socket whose axis passes through a longitudinal slit in the beam. Two equal wheels, one below each end of the beam, turn on axes that pass through pipes fixed at *a b*, near its extremities, and a steel chain passes over the wheels as a band by which motion may be communicated from one to the other. Two arms *f f* slide in sockets along the lower face of the wheels, just under their centers, one of which bears at its extremity *h* a metallic tracer, having a handle by which its point may be carried over the lines of any design, while at the extremity *g* of the other arm is a pencil, fixed in a metallic tube which slides in a pipe and is raised by a string, when required, the pressure on the paper being maintained by a weight.

The wheels being exactly equal in diameter, the arms attached to them, when once set parallel to each other, will remain so when the wheels are revolved.

For use, the instrument is set by sliding the central beam, so that the distance *b c* shall bear the same proportion to *a c* as the drawing to be copied is intended to bear to the copy.

The distances *b g*, *a h*, are also regulated to the same proportion. The center-piece and arms are graduated for this purpose, so as to admit of being set to any desired ratio.

Ei′do-scope. An instrument on the principle of the kaleidoscope, which produces an infinite variety of geometrical figures by the independent revolution of two perforated metallic disks on their axes. It may be employed in conjunction with the magic-lantern, when rapidly rotated causing flashing rays of light, forming singular combinations to appear upon the screen. Variously colored glass disks may be used, producing striking variations and combinations of color. — *Mechanical Magazine*, N. S., Vol. XVII. p. 35.

Eight-een′-mo. A book whose sheets are folded to form eighteen leaves. Sometimes written *octodecimo;* and usually indicated 18mo, or 18°.

Eight-line Pica. (*Printing.*) A type whose face has eight times the depth of pica. French, *double-canon.*

E-ject′or. 1. A device wherein a body of elastic fluid, such as steam or air, under pressure and in motion is made the means of driving a liquid such as water or oil. The effect of a body of escaping steam in setting liquids in motion was observed long since, but the most notable instance is the Giffard Injector (see INJECTOR), which is used as a feed-water pump for steam-boilers. The *ejector* acts on

Fig 1833.

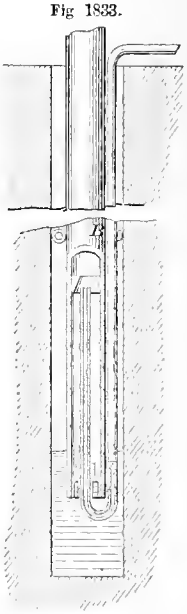
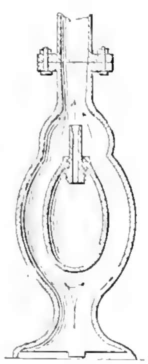


Fig. 1834.

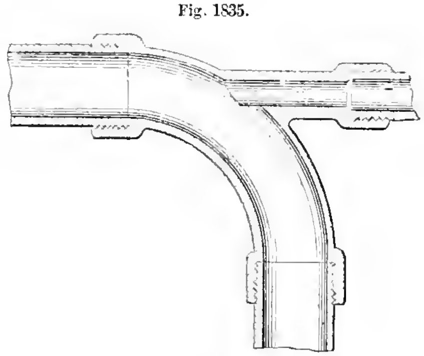


Ejector

Pease's Oil Well Ejector.

a similar principle, but is applied to *eject* or lift liquids, as in the example (Fig. 1833), where it is an oil-well pump. *B* is a pipe which proceeds from the surface of the ground to near the bottom of the well; its lower end is closed by a valve which opens upward. A steam-pipe passing down alongside the main pipe is recurved upwardly, and emits steam

Fig. 1835.

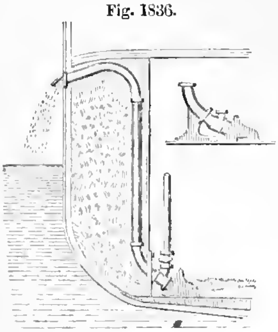


Ejector.

just in the throat of the contracted aperture. The effect is to draw up liquid by the force of the steam-blast and carry it through the aperture, and so upwardly to the top. See also Figs. 59 to 64, inclusive.

Fig. 1834 is upon the same principle, the steam or air issuing through the small axial-pipe and passing into the up-cast pipe, drawing with it the liquid from the lower pipes which surround the ejector-nozzle.

Fig. 1836.



Ashes-Ejector.

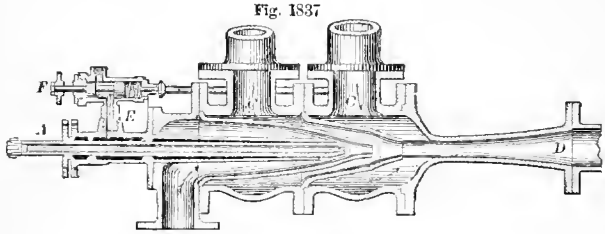
Fig. 1835 only differs in the mode of application, the bent pipe having an unobstructed passage in the nozzle for the admission of steam or air, communicating with the said passage on its back or outer curved side at a point directly opposite to and in line with the outlet or discharge opening.

2. That device in a breech-loading fire-arm which withdraws the empty cartridge-case from the bore of the gun.

3. A device on shipboard (Fig. 1836) for carrying up the ashes from the stoke-holes of steamships and discharging them overboard. The ashes are shoveled into a box, and a steam-jet being driven into the mouth-piece of the pipe causes an induced current of air which carries the ashes along with it, up the pipe, and overboard above the water-line.

E-ject'or-con-dens'er. (*Steam-engine.*) A form of condenser worked by the exhaust steam from the cylinder. In the example it is shown as applied to a pair of engines. The apparatus consists essentially of three concentric tubes terminating in conoidal nozzles, and opening into the hot-well or waste-water receptacle by a common and gradually widening or trumpet-shaped mouth-piece *D*; the inlet-tube *B* is in communication with the water-tank from which the current of injection-water is obtained, while each of the other tubes *C* conveys the exhaust steam from one of the cylinders.

Fig. 1837



Morton's Ejector-Condenser.

A is a regulating-spindle for adjusting the water-supply; *B*, the water-inlet; *C C*, the exhaust passages; *D*, the discharge passage; *E*, the steam-inlet; *F*, a self-adjusting steam-valve. In starting, steam is admitted at *E*, and passing along the axial-pipe, issues at the nozzle, drawing with it water from cold-water pipe *B*, which condenses the steam from the exhaust passages *C C* of the respective cylinders, and has momentum enough to carry the condensed steam and itself to the hot-well.

Eke'ing. (*Shipbuilding.*) *a.* A piece fitted to make good a deficiency in length on the lower part of the supporter under the cat-head, etc.

b. The piece of carved work under the lower end of the quarter-piece at the aft part of the quarter-gallery.

E'lai-om'e-ter. An instrument for detecting the adulteration of olive-oil.

E-las'tic-bulb Syr'inge. A syringe having a bulb of caoutchouc, whose expansion and contraction acts as a pump. See BREAST-PUMP; ATOMIZER.

E-las'tic Bands. Made of caoutchouc, naked or covered. The former are cut from flattened cylinders of rubber of proper diameter and thickness between a duplicate series of circular knives acting after the manner of shears; the latter are made by cutting continuous slips from a sheet of vulcanized rubber of the required thickness, wound upon a reel, by means of a knife with slide-rest motion. These strips are then covered with cotton or silk, and woven in an endless web. See CAOUTCHOUC.

E-las'tic-fab'ric Loom. One having mechanical devices for stretching the rubber threads or *shirrs*, and holding them at a positive tension while the fabric is woven.

E-las'tic Goods. Those having elastic cords, called *shirrs*, inserted in a fabric or between two thicknesses.

E-las'tic Mold. Elastic molds of glue for taking casts of *undercut* objects were invented by Douglas Fox, Derby, England.

The body to be molded is oiled and secured about an inch above the surface of a board, and is then surrounded by a wall of clay rather higher than itself, and about an inch distant from its periphery. Into this, warm melted glue, just fluid enough to run, is poured, completely enveloping the object. When cold, the clay wall is removed, and the mold delivered by cutting it into as many pieces as are required, either with a sharp knife or by threads previously placed in proper situations about the object. The pieces are then placed in their proper positions, and bound together. The mold is designed particularly for taking casts in plaster-of-paris, but molten wax, if not too hot, may also be employed.

E-las'tic Pis'ton-pump. A pump described in Dr. Gregory's "Mechanics" consists of an elastic bag provided with a valved board on top, and operating over a valved diaphragm. The trunk in which it operates is a square box, and the piston moves without friction against the trunk in which it works. The bag is of water-proof canvas or leather, with occasional rings.

A somewhat similar pump, recommended for a bilge-water pump, and for pumping out leak-water, is known as Cracknell's, and was somewhat famous in England forty years since. It had a pliable diaphragm of leather attached to the plunger-rod, and a valve on top like the pump just described. As the leather diaphragm was driven down and drawn up alternately, it filled with water and then lifted it, the lower valve rising as the plunger lifted. See BAG-PUMP.

E-las'tic Pro-pel'ler. A form of ship's propeller invented by Macintosh, in which the blades are of flexible steel, which assume a more and more nearly disk form as the speed and consequent resistance of the water is increased.

E-las'tic Type. Type made of compounds of caoutchouc, which will accommodate themselves to a somewhat uneven surface in printing, and in which a form of said type may be lapped around a curved printing-surface.

E-lat′er-om′e-ter. A pressure-gage for air or steam.

El′bow. 1. The junction of two parts having a bent joint. A *knee* or *toggle* joint. An abrupt angle.

2. A bend, as of a stove-pipe, a wall, a parapet.

3. A support for the arm, elbow high, as the arm of a chair.

4. A voussoir of an arch which also forms part of a horizontal course. An obtuse angle of a wall.

5. (*Joinery.*) The sides or flanks of a paneled recess; especially the two small pieces of framing which occur on each side of a window immediately below the shutters when the window-jambs are carried down to the floor, forming a slight recess.

El′bow-board. (*Carpentry.*) The board at the bottom of a window on which the elbows of a person are supported when leaning.

El′bow-tongs. A crucible tongs with jaws bent between the joint and chaps.

E′lec-trep′e-ter. An instrument for changing the direction of electric currents.

E-lec′tri-cal Ap′pa-ra′tus. Gilbert, in his book "De Magnete," 1600, first introduces into the nomenclature of the sciences the word "electric," deriving it from *electron* (Gr. *amber*), which was the only substance known to the ancients that acquired the property of attracting light bodies when rubbed. He gives a list of bodies, as diamond, sapphire, crystal, glass, sulphur, sealing-wax, and others, possessing the electric property, which he very properly distinguishes from magnetic power, the former attracting all light bodies, the latter iron only. He regarded magnetism and electricity as two emanations of one fundamental force. He considered the earth as a magnet, and the lines of equal declination and inclination as having their inflections determined by distribution of mass, or by the forms of continents and by the extent of the deep intervening oceanic basins. Gilbert was surgeon to Queen Elizabeth and James I., and died in 1603.

The electric-telegraph preceded the electro-magnetic by many years. See ELECTRIC-TELEGRAPH.

Otto Guericke, of Magdeburg, discovered that there was a repulsive as well as an attractive force in electricity, observing that a globe of sulphur, after attracting a feather to it, repelled it until the feather had again been placed in contact with some other substance. Newton, in 1675, observed signs of electrical excitement in a rubbed plate of glass. Hawkesbee, who wrote in 1709, also observed similar phenomena; and Dufay in the "Memoirs of the French Academy," between 1733 and 1737, generalized so far as to lay down the principle that electric bodies attract all those which are not so, and repel them as soon as they have become electric by the vicinity or contact of the electric body.

Dufay also discovered that a body electrified by contact with a resinous substance repelled another electrified in a similar way, and attracted one which had been electrified by contact with glass.

He thence concluded that the electricity derived from those two sources was of different kinds, and applied the names vitreous and resinous to them. Franklin attributed this difference to an excess or deficiency of the electric fluid, the former condition existing in electrified glass and the latter in resins.

Otto Guericke had observed that his sulphur globe, when rubbed in a dark place, emitted faint flashes of light, and shortly afterward it was noticed that a similar phenomenon occurred at the surface of the mercury when the barometer was shaken; a fact which one of the celebrated mathematicians, Bernoulli, attempted to explain on the Cartesian system, but which was afterwards correctly attributed by Hawkesbee to electricity. Wall, in 1708, observed the sparks produced from amber, and Hawkesbee noticed the sparks and "snapping" under various modifications.

Dufay and the Abbé Nollet were the first to draw sparks from the human body; an experiment which attracted great attention, and became a species of fashionable diversion at the time.

The discovery of the Leyden jar is attributed to Cunœus of Leyden, in 1746, who, while handling a vessel containing water in communication with an electrical machine, was surprised at receiving a severe shock; a similar event had happened the year previous to Von Kleinst, a German prelate.

Gray in 1729 discovered that certain substances were possessed of a conductive in contradistinction to an electric power; and afterwards Nollet passed a shock through a circle of 180 men of the French guards, and along a line of men and wires 900 toises in length, while Watson in England ascertained that the transmission of the shock through 12,000 feet of wire was sensibly instantaneous.

Franklin in 1747 pointed out the circumstances on which the action of the Leyden jar depends, showing that the inside is positively and the outside negatively electrified, and that the shock is produced by the restoration of the equilibrium when communication is established between them. Monnier the younger discovered that the electricity which bodies can receive depends on their surface rather than their mass, and Franklin soon found that "the whole force of the bottle and power of giving a shock is in the glass itself"; he farther, in 1750, suggested that electricity and lightning were identical in their nature, and in 1752 demonstrated this fact by means of his kite and key; about the same time D'Alibard and others in France erected a pointed rod forty feet high at Marli, for the purpose of verifying Franklin's theory, which was found to give sparks on the passage of a thunder-cloud. Similar experiments were repeated throughout Europe, and in 1753 Richman was instantly killed at St. Petersburg by a discharge from a rod of this kind.

The more important discoveries since those days relate rather to electricity produced by voltaic or magnetic action. See, under the following heads: —

E-lec′tri-cal and Mag-net′i-cal Ap-pli′-an-ces.

Annunciator.	Doubler.
Anode.	Dry-pile.
Armature.	Earth-battery.
Astatic needle.	Earth-plate.
Battery.	Electrepeter.
Calorimotor.	Electrical apparatus.
Carbon-battery.	Electric alarm.
Catelectrode.	Electrical machine.
Cathode.	Electric annunciator.
Cell.	Electric balance.
Circuit.	Electric battery.
Circuit-breaker.	Electric bridge.
Circuit-closer.	Electric cable.
Commutator.	Electric clock.
Compound battery.	Electric escapement.
Condenser. Electric	Electric fuse.
Conductor.	Electric governor.
Constant battery.	Electric harpoon.
Couple.	Electric heater.
Current-regulator.	Electric helix.
De Luc's column.	Electric indicator.
Dip.	Electric lamp.
Dipping-needle.	Electric light.
Discharging-rod.	Electric log.

Electric loom.
Electric meter.
Electric pendulum.
Electric piano.
Electric railway-signal.
Electric regulator.
Electric signal.
Electric steam-gage.
Electric switch.
Electric telegraph.
Electric time-ball.
Electric torch.
Electric wand.
Electric weighing-apparatus.
Electric whaling-apparatus.
Electro-ballistic apparatus.
Electro-blasting.
Electro-chemical telegraph.
Electro-chronograph.
Electrode.
Electro-dynamic engine.
Electro-engraving.
Electro-etching.
Electro-gilding.
Electrolyte.
Electro-magnet.
Electro-magnetic clock.
Electro-magnetic engine.
Electro-magnetic machine.
Electro-magnetic regulator.
Electro-magnetic telegraph.
Electro-magnetic watch-clock.
Electro-medical battery.
Electrometer.
Electro-motor.
Electro-negative.
Electronome.
Electrophorus.
Electro-plating.
Electro-positive.
Electro-puncturing.
Electroscope.
Electrotint.
Electrotype.
Filings-separator.
Galvanic battery.
Galvanizing-iron.
Galvanography.
Galvanometer.
Galvanometric multiplier.
Galvanoplastic process.
Galvanoscope.
Geisler-tube.
Hydro-electric machine.
Inclinatorium.
Inclinometer.
Induction apparatus.
Induction coil.
Inductometer.
Insulated wire.
Insulating-stool.
Insulator.
Inversor.
Leyden battery.
Leyden jar.
Lighting gas by electricity.
Lightning-arrester.
Lightning-conductor.
Lightning-rod.
Line-wire.
Magnet.
Magnetic battery.
Magnetic compensator.
Magnetic curative-appliances.
Magnetic guard.
Magnetic hone.
Magnetic needle.
Magneto-electric apparatus.
Magneto-electric machine.
Magneto-electric telegraph.
Magnetograph.
Magnetometer.
Manipulator.
Mariner's compass.
Meteorometer.
Multiplier.
Negative.
Organ. Electric
Pantelegraph.
Paragrandine.
Paragrele.
Pendulum. Electric
Pile.
Polarized armature.
Pole.
Positive.
Prime-conductor.
Receiving-magnet.
Reel-telegraph.
Relay-magnet.
Repeater.
Resistance-box.
Resistance-coil.
Rheometer.
Rheomotor.
Rheophone.
Rheoscope.
Rheostat.
Rheotome.
Rheotrope.
Rubber.
Ruhmkorff battery.
Sideroscope.
Signal-box.
Sounder.
Submarine-cable.
Switch.
Telegraph (varieties, see TELEGRAPH).
Telegraph-cable.
Telegraph-clock.
Telegraphic signal.
Telegraph-indicator.
Telegraph-instrument.
Telegraph-key.
Telegraph-wire.
Terminal.
Thermo-electric pile.
Torsion-balance.
Torsion-electrometer.
Trough.
Unit-jar.
Variation-compass.
Volta-electrometer.
Voltaic battery.
Voltaic light.
Voltaic pile.
Voltameter.
Voltaplast.
Voltatype.
Zambonis-pile.

E-lec'tric A-larm'. An instrument, otherwise known as a *thermostat*, used for giving an alarm when the temperature rises to a point at which the instrument completes the circuit. This is used in stoves and hot-houses, to indicate excess or lack of temperature, and as a maximum thermometer-alarum or fire-alarm, which is made by carrying one platinum wire in connection with a battery and bell into the bulb of a mercurial thermometer, and another wire down the tube to the degree it is not desired to exceed. When the mercury rises to this point, the circuit is completed, and notice is given by the ringing of the bell. One form of the minimum temperature alarm consists of a spirit-thermometer, the bulb of which is placed above and the tube curved in a U-shape. A platinum wire is carried into the bulb and down to the degree of heat it is wished to notify. Below this minimum the curvature is filled with mercury, which is in free communication with a second platinum wire. As the alcohol contracts with the cold, the mercury will, of course, rise, and, reaching the first platinum wire, complete the circuit and give the warning. One bell and the same battery will serve for the two thermometers; but it will be necessary to interpose a commutator to ascertain through which circuit the current is passing, and whether a rise or fall is indicated when the bell is rung.

Fire-alarms constructed on the same principle are placed in different apartments of a building, the increased temperature in that where fire happens to first break out expands a wire or column of mercury, which, by completing a circuit, sounds an alarm. The most compact form of the thermostat is that resembling the chronometer-balance. See THERMOSTAT; FIRE-ALARM.

E-lec'tri-cal Ma-chine'. An apparatus for generating, or rather collecting or exciting, electricity by means of friction.

The Greeks were aware that amber, when rubbed, acquired the power of attracting and repelling light bodies; and for many ages this property was supposed to be peculiar to amber, from the Greek name of which (ἤλεκτρον) the word "electricity" was derived. It was subsequently discovered that the same effect was produced by resinous substances rubbed with flannel, and by glass when rubbed with silk; and our readers may have noticed that by stroking a cat's back smartly with the hand in clear frosty weather, a crackling noise accompanied by a tingling sensation is produced.

Substances in the condition referred to are said to be electrically excited. This excitement is termed positive if glass be the material employed, and negative if resin be used; the kind of electricity developed by each substance having a tendency to attract that derived from the other, and to repel that of the same kind as itself. According to the theory of Dufay, the two kinds were called vitreous and resinous; the former being derived from glass and corresponding to the positive of Franklin, and the latter from resin, corresponding to the negative. It is by the latter terms, positive or +, and negative or —, that the two kinds are now universally known. See *supra*, page 777.

In machines for developing frictional electricity in quantities, glass is the material employed, either in the form of a hollow cylinder rounded at the ends or of a circular plate. These are rotated in contact with a leather-covered cushion, upon the surface of which a thin layer of an amalgam composed of tin, zinc, and mercury is spread, and a suspended flap or apron of silk.

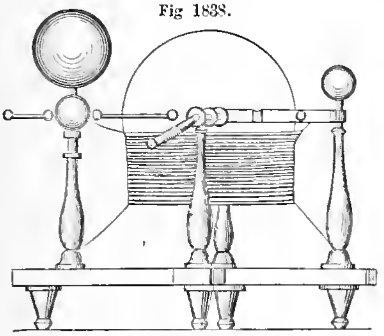
Gilbert, in 1600, conjectured the fundamental identity of the forces known as magnetism and electricity, and measured the strength of the electricity excited by rubbing amber, glass, resin, etc. His electrometer was an iron needle poised on a pivot.

Otto Guericke, of Magdeburg, recognized phenomena of repulsion. "He heard the first sound and saw the first light in artificially excited electricity." Newton saw the first traces of an "electric charge" in 1675, in some experiment with a rubbed plate of glass.

Although Wall in 1708, Gray in 1734, and Nollet, conjectured the identity of frictional electricity and lightning, yet Franklin was the first to attain the experimental certainty by his well-known kite experiment in 1752.

Electrical machines were formerly made cylindrical, but are now more frequently made with a circular glass disk rotated by a hand-crank. The glass passes between rubbing surfaces, and the electric current

Fig 1838.



Electrical Machine.

which is generated passes to the conductors on each edge of the disk, and thence to the prime conductor, when it passes to a Leyden jar or other object, as may be desired. The plate-machine of the University of Mississippi has two plates each 6 feet in diameter. One made for the London Polytechnic Institute has a plate 10 feet in diameter driven by a steam-engine of 4-horse power.

See Deschanel's "Natural Philosophy," Part III. pp. 533–545.

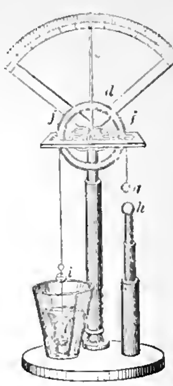
E-lec'tric An-nun'ci-a'tor. A form of annunciator in which a circuit wire is the means of shifting the shield covering the number aperture on the dial, or performing other duty to expose the number of the room. The guest in his room touches a stud upon the wall; the circuit being made or broken, the effect is evidenced by the exposure of the room number in the hotel-office. It is an electromagnetic expedient as a substitute for a pulling wire. See ANNUNCIATOR.

E-lec'tric Bal'ance. An instrument for measuring the attractive or repulsive forces of electrified bodies. A form of electrometer.

It consists of a graduated arc *a b* supported by a projecting plate of brass which is attached to the perpendicular column. A wheel *d*, the axis of which is supported on anti-friction rollers *f f*, and is concentric with that of the graduated arc *a b*, carries an index *c*.

Over this wheel, in a groove on its circumference, passes a line, to one end of which is attached a light ball of gilt wood *g*, and to the other a float *i l*, which consists of a glass tube about two tenths of an inch in diameter, terminating in a small bulb *l* at its lower end, which contains a small portion of mercury or some very fine shot, put into it for the purpose of adjusting the instrument, so that the index *c* may point to the zero division or center of the graduated arc. The difference between the weights of the float when in and out of water is known, and the diameter of the wheel carrying the index is such that a certain amount of rise or fall of the float causes the index to move over a certain number of graduations on the arc. The body whose electricity is to be measured is presented at *h*, and its attractive or repulsive power on the ball *g* is estimated by the rising or falling of the float in the fluid, and consequent motion of the index *c*, as shown by the graduated arc.

Fig. 1839.



Electric Balance.

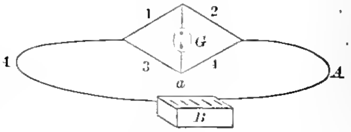
When the attractive force of the two bodies is to be estimated, the line passing over the wheel *d* must be formed of two parts, the lower part being of silver thread and the remainder of silk; when their repulsive force is to be estimated, the whole is of silk. See ELECTROMETER; GALVANOMETER.

E-lec'tric Bat'ter-y. A series of Leyden jars having all their interior and exterior coated surfaces connected with each other by means of conductors, so that the accumulated electricity of the whole may be made to act together, resembling the effects of lightning itself.

A large battery of this kind is capable of polarizing bars of iron or steel, and instantaneously melting iron or tin wire into globules, which are dispersed in all directions, the fusion of the latter metal being accompanied by a cloud of blue smoke, a dazzling flash, and a loud report. Small animals are killed by it, and a violent shock given to the human system. See LEYDEN-JAR.

E-lec'tric Bridge. (*Electricity.*) A term applied to an arrangement of electrical circuits used for measuring the resistance of an element of the circuit. The most generally known and used are the Wheatstone "bridge" or "balance," and that of the British Association. The former in substantial respects is adopted in the Siemen's universal galvanometer, in such general use.

Fig 1840.



Electric Bridge.

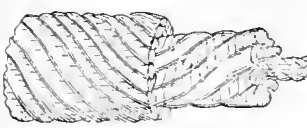
The principle involved is that an electrical circuit being divided into two branch-circuits, and again united, and the branches "bridged" or connected by a "short cut," if the resistances in the branches on one side of the "bridge" are in the same ratio to each other as the resistances on the other side, no current will traverse the "bridge"; if the ratios are not equal, a current will traverse the bridge.

A A, metallic circuit from battery *B* divided into branches 1, 2, and 3, 4, which again unite. Calling resistance "R," when R 1 : R 3 : : R 2 : R 4, an equilibrium or "balance" is established, and there is no appreciable current in the "bridge" *a b*, in which is inserted the galvanometer *G*.

In use, the resistance of one of the members, say 4, being known, the unknown resistance is inserted in 2 and its resistance calculated from the deflections of the needle in the galvanometer, caused by the current thrown through the "bridge." See DUPLEX-TELEGRAPH.

E-lec′tric Ca′ble. Various forms of telegraph cable for submarine uses have been proposed. That between England and Ireland is composed of a single copper wire covered with gutta-percha, surrounded by hempen yarn, and the whole protected by ten No. 8 iron wires twisted. That between Dover and Calais has four copper wires covered with gutta-percha twisted into a rope, and protected in similar manner. It weighs seven, and the Irish two, tons to the mile. The first Atlantic cable was composed of seven No. 22 copper wires, covered with gutta-percha, hempen yarn, and an outside coating of iron wire. This weighed 19 cwt. to the mile. The cut shows a cable with coils diversely twisted. See TELEGRAPH CABLE.

Fig. 1841



Electric Cable.

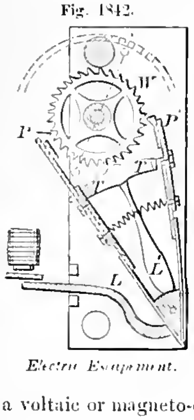
E-lec′tric Clock. A dial with hands and going-train impelled by recurrent impulses from an electro-magnet. The first known clock of this kind was invented by Wheatstone and exhibited by him in 1840. Appold, Bain, Shepherd, and others have contrived clocks on the same principle. See ELECTRO-MAGNETIC CLOCK.

E-lec′tric Es-cape′ment. A device actuated by electric impulse which intermittingly arrests the motion of the scape-wheel and restrains the train to a pulsative motion, — acting, in fact, in the place of a pendulum. An electric pendulum at a central station may be the regulator of numerous distant clocks with electric escapements, with each of which it is connected by circuit or circuits. In some cases the device has alternately a detent and impulse action, and is the motor as well as regulator.

Devices in which a train is set in motion, or a machine started or stopped, are not strictly escapements, but may be considered as *electrical-governors* or *electrical-regulators*.

In that illustrated, the lever *L* and its corresponding one on the opposite side, not shown, are caused to vibrate to the action of the circuit; these cause the anchor-shaped piece *L′ T T* to strike alternately against each of the pallets *P P′*, which are fastened by springs, and yield in either direction, so as to alternately retain and release the scape-wheel *W*.

Fig. 1842.



Electric Escapement.

E-lec′tric Fuse. A device used in blasting to explode the charge. The fulminate or the charge itself is lighted by means of an electric spark or a resistance section of fine platinum wire, which is heated to redness by the passage of an electric current induced by a voltaic or magneto-electric battery. See FUSE.

E-lec′tric Gov′ern-or. One in which a part of a fly-wheel, say a segment of the rim, is made to move radially outward when the wheel revolves at a rate above a preappointed speed, and thereby comes in contact with a metallic tongue completing an electric connection, which is utilized to move a butterfly-valve or other device which concerns the transmission of power.

Governor-balls flying out to a certain distance may make or break an electric connection to produce the same result, or sound an alarm.

Electro-magnetic action is also used to start and stop machines, and operate stop-motions.

E-lec′tric Har-poon′. An application of the electric force to the explosion of a bursting-charge in a harpoon or bomb-lance. A copper wire is carried through the line, and, when a circuit is established by the harpooner, a resistance-section in the fuse of the bomb-lance ignites the charge. See HARPOON; BOMB-LANCE.

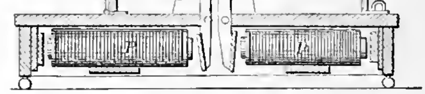
E-lec′tric Heat′er. A device in which a fine platinum wire heated by a passing electric current is made to communicate sensible heat as a means of warming or burning, as the case may be. It has been used as a local cautery, has been suggested for amputating, and for some other purpose, which it would excite a smile to name.

It is a lower application of the same principle as is developed in the electric light; a body of relatively great resistance is included in a circuit, and, failing to carry the electricity, a part of the latter takes the form of heat.

E-lec′tric He′lix. A coil of copper wire around a bar of soft iron; the coil forms part of an electric circuit, and confers polarity upon the iron. The two constitute an electro-magnet.

E-lec′tric In′di-ca′tor. The apparatus shown in Fig. 1843 is for indicating electro-magnetic currents, and consists of a wheel having figures upon its periphery turned by a star-wheel E^2 upon its shaft. The star-wheel is actuated by pawls *J J K K*, connected with armature levers *G* G^2 turning one cog, equal to one figure, at each completion of the circuit through one of the spool-magnets *P P*. The two magnets are arranged to cause opposite rotation, and either may be connected with the operating-key by a switch. The circuit passes through the axis of the key and through numbered buttons upon a disk. The key being brought in contact with a button causes one movement of the numbered wheel, and each time the key comes in contact with a button the wheel is moved one figure, and no more.

Fig. 1843



Electric Indicator.

E-lec′tric Lamp. A box or case provided with an electric lighting-apparatus. See ELECTRIC LIGHT.

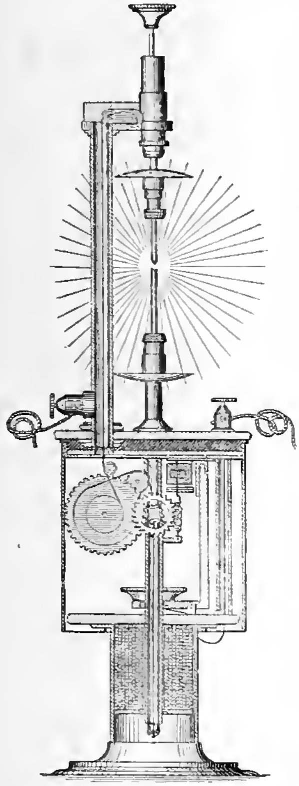
E-lec′tric Light. An intense light generated by passing an electric current between two pieces of charcoal fixed at the positive and negative ends of the circuit.

The electricity developed may be either derived from voltaic action or from magnets in connection with a series of helixes arranged on a rotating wheel, the latter source being preferred for practical application to illuminating purposes.

The lights of the natural lanterns carried by fireflies, glow-worms, and some species of nocturnal moths, may be considered as *electric* lights. Though classed as phosphorescent, some of them are intermittent, and we suppose the nervous action by which they are flashed into brilliancy to be in the nature of what we call a voltaic impulse from the battery, — the brain.

The electric light was first brought into notice in 1846. The patent of Greener and Staite of that year embraced an arrangement whereby small lumps of pure carbon, inclosed in air-tight vessels, were rendered luminous by currents of galvanic electricity. Two small cylinders or bits of pure carbon were placed nearly in contact with their points toward each other, and maintained at a constantly equal distance apart by means of clock-work, which slowly advanced them as they were consumed by combustion. Through these the current of a galvanic battery was transmitted, so that the circuit would not be complete without traversing the small space between the points of the two pieces of carbon; this generated an intense heat at this spot, causing the combustion of the carbon, which was accompanied by an extremely brilliant light. The chief practical difficulty was found to be in maintaining the points at such a distance from each other as to render the light continuous instead of intermittent.

Fig 1844.



Electric Light

This is now effected by means of an electro-magnet and a clock movement, the duty of the latter being to bring the two points together as they are gradually worn away by the passage of the electric current, while the former checks the clock action when not required. The positive carbon pencil is found to wear much more rapidly than the negative; and in order to maintain the point where the light is produced at a uniform elevation, the cord by which each point is advanced is caused to pass around a barrel, larger for the positive and smaller for the negative, so as to take up unequal quantities of cord.

When the battery employed is very powerful, the electricity between the points assumes the form of an arc of dazzling brilliancy. With 600 Bunsen's cells arranged consecutively, an arc 7.8 inches in length was obtained; and when the 600 cells were arranged in six parallel series, a still more powerful light was produced.

According to Fizeau and Foucault, the intensity of the electric light with a battery of 46 pairs of Bunsen burners was 235, that of the sun being taken at 1,000, while with 80 pairs it was but 238.

During the excavation of the docks at Cherbourg two apparatus of this kind were employed, maintained by a single battery of 50 pairs of Bunsen, affording sufficient light for 800 workmen.

The magneto-electric light was applied for illuminating the lighthouse at Dungeness, England, in 1862, and was introduced at La Hève, France, a year or two later. The machines employed at each are very similar in construction and entirely so in principle, the English apparatus being arranged after the following manner: —

Eighty-eight bobbins or coils of copper wire are wound about an equal number of cores of soft iron, and arranged in two parallel rings, forty-four in each ring, at the circumference of a wheel 5 feet in diameter, their axes being parallel to that of the wheel. The axes of each set are placed midway between those of the other. Sixty-six powerful horseshoe magnets are firmly fixed in three rings exterior to the wheel and parallel to each other, twenty-two in each ring, their poles being in the planes of their respective rings, and distant from each other a space equal to that which separates the centers of the bobbins.

The magnets of the several rings are similarly situated upon the circumference, their poles being alternate; but the poles of those in the inner and outer rings face contrary poles in the central ring.

As the wheel is turned, which is effected by connection from a steam-engine working at a power of one and a half to two horses, the cores with their bobbins pass between the successive poles of the fixed magnets, and as the spaces between the bobbins are equal to those between the poles of the magnets, all the bobbins of one ring pass the poles simultaneously; but as these are arranged intermediately between those of the other ring, it follows that while one set of bobbins is passing the poles the other set is half-way between them; thus alternate currents of opposite character are generated in each set of bobbins, the polarity being changed at the moment of polar passage, so that while the current in one set of bobbins is in the middle of its flow the other undergoes a sudden reversal.

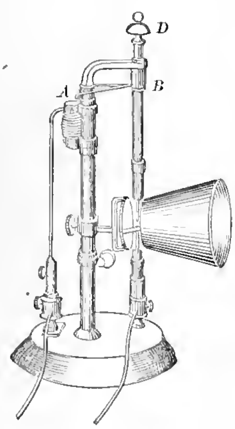
By means, however, of "commutators," all the successively opposite currents are turned in the same direction in the circuit which conveys the electricity to the carbon points; any fluctuations in the strength of the currents are thus compensated so as to render the resulting intensity very nearly constant. The velocity of rotation imparted to the wheel is about 110 turns per minute, causing nearly 10,000 changes of polarity in that time. The intensity of the light produced depends on the velocity of rotation, being comparatively feeble at a slow speed and increasing up to a certain point, when an acceleration of the velocity seems rather to diminish than increase the light.

In the French machine, sixty-four bobbins are arranged in four sets, and revolve between five sets of magnets, eight in a set. They are so arranged as to pass the poles of the magnets simultaneously, and a commutator is dispensed with. This arrangement, by making each of the carbon points alternately the positive and negative poles of the circuit, insures their equal wear, and permits the use of a simpler apparatus for maintaining a uniform distance between them.

The apparatus actually employed at La Hève lighthouse comprised two of the above machines, each driven by a separate engine, affording a light equivalent to 3,500 Carcel burners, or more than six times that of an oil light of a similar class. Its fog-penetrating power is said to be very superior to that of the latter.

In Browning's electric light, worked by a battery of six Grove cells, the principle adopted is to let the carbon points touch each other, and to clamp them in that position, so that the current has to burn an interval between the two points for itself. In the accompanying cut, *D* is a brass rod carrying the upper carbon point, and sliding easily in its vertical bearings by its own weight. Directly the upper point touches the lower one, the current is established, and the little electro-magnet *A* at once pulls down its armature, which clamps the upper brass rod at *B*. Directly the current is broken by the wasting away of the carbons, the electro-magnet *A* ceases to hold the brass rod, which then falls, and re-establishes the communication.

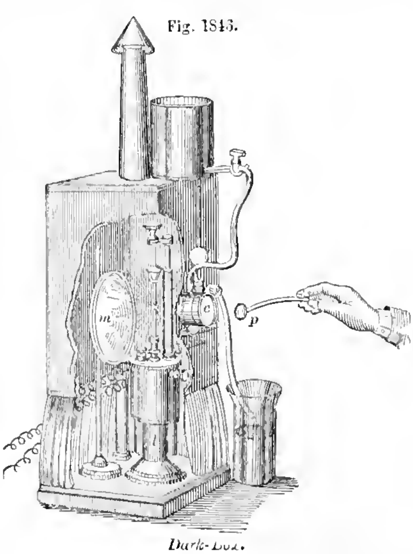
Fig. 1845.



Browning's Electric Light.

Professor Tyndal, in his experiments, concealed the electric light in what he termed a *dark-box*, in order that all the issuing beams may be emitted at one

Fig. 1846.



Dark-Box.

orifice, and the experiments be the more vivid in the absence of diffused light in the room. *l* is the electric lamp, the rays of which are focused at any desired point. The apparatus is adapted for a large range of experiments, but in the figure is shown with Tyndal's *ray-filter c*, in which the luminous rays are filtered out by passing the beam through an opaque solution of iodine in bisulphide of carbon, while the invisible heating or ultra-red rays are transmitted. A current of cool water circulates in the jacket on the outside of the cell to keep the volatile bisulphide cool. *p* represents a piece of blackened platinum held in the focus of the mirror to be heated to redness by the invisible heat-rays, although no light passes out through the solution.

The electric light on the Victoria tower of the British Houses of Parliament at Westminster is generated by a Gramme magneto-electric machine, driven by an engine in a vault of the House of Commons, and connected with the signaling-point by two copper wires half an inch in diameter and 900 feet long. The machine consists of a permanent horseshoe-magnet, between the poles of which revolves an electro-magnet, consisting of a ring of soft iron round which is wound an insulated conducting wire, continuous, but disposed in sections. The light apparatus is placed within a lantern 5 feet high, 4 feet wide, and having a semicircular glass front, and the light may be directed in a horizontal arc of 180°. Two lamps are used alternately, the carbon-points lasting four hours. Expense, twenty cents per hour.

E-lec′tric Log. An electric circuit through the log-line to the detent of an escapement in the register-log, so that by touching a key on deck a circuit may be completed, an armature attracted, and thus the starting and stopping of the mechanical register in the log be exactly timed. See Log.

E-lec′tric Loom. In 1852 an electric loom was exhibited by Bonelli at Turin. The invention was at that time in a crude state, but has since been much improved. The object is to dispense with the perforated cards required in the Jacquard apparatus. For this purpose, an endless band of paper covered with tin-foil is used, on which the required pattern is traced with a varnish, rendering the parts thus covered nonconducting.

This band is caused to pass under a series of thin metallic teeth, each connected with a small electro-magnet, which operate a series of pistons that open or close the holes in a perforated metallic plate (answering to the Jacquard card), through which pass the needles governing the hooks by which the warp-threads are lifted or let fall, according as the electro-magnets are in action by contact of the teeth with the metallic surface of the band, or inoperative by contact with the varnish.

E-lec′tric Me′ter. See Electrometer; Electroscope.

E-lec′tric Pen′du-lum. The ordinary element of an electric clock. A point below the bob of the pendulum passes through a globule of mercury, the time of contact being indicated on a traveling fillet of paper. In another form the bob comes in contact, at the limit of each stroke, with a delicate spring, which makes the electric connection.

Besides its use as a chronograph for recording atmospheric, astronomical, and other observations, it is also employed to secure isochronous beats of distant pendulums. A mode of keeping distant chronometers in exact simultaneous pulsation by which longitude may be exactly determined; the invention of Dr. John Locke of Cincinnati.

E-lec′tric Pi-a′no. One provided with a series of electro-magnets, each corresponding to a key of the instrument, the armatures of which are caused to strike the keys when the circuit is closed. This may be effected by means of perforated cards through which pins are caused to pass and again retracted in any required sequence, after the manner of the Jacquard apparatus. The device may be connected with a number of instruments at great distances apart, so that they may be caused to play the same tune simultaneously.

In 1868, a contrivance on this principle for playing the organ was exhibited in London. It was operated by means of a keyboard, and by enabling the performer to be placed at some distance from the instrument it was claimed that he was better able to judge of its tones, so as to play with more effect.

E-lec'tric Rail'way-sig'nal. A device for communicating messages or warnings as to the place or condition of a train on the track, in regard to stations left or approached, or to other trains on the same line.

1. An automatic signal operated by the wheel on the track to indicate the passage of a given point by a train, to signal the approach to a crossing in advance; or to the rear, to show the distance of a preceding train; or to signal to a station the position of trains on a track.

2. To enable an operator on a car to communicate with a station at a distance, or with an observer or operator on another train on the same line.

3. To communicate between parts of the same train, as between the conductor and engineer, etc.

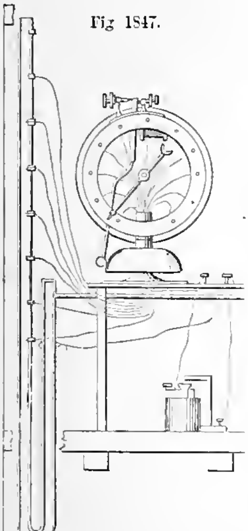
E-lec'tric Reg'u-la tor. A device by which an electro-magnetic circuit is made the means of reaching a machine to stop it or start it. The applications are numerous and various.

In gas-lighting by electricity, the gas-cock at a distance is turned by a succession of impulses derived from a battery, communicated through a wire circuit, and imparted to an armature connected with the plug or valve.

As a means of controlling machinery at a distance, the electric circuit, by its magnetic power, affords means for putting a detent into action or removing it.

Stop motions in machinery are also made effective by electric connection, as, for instance, in spinning and knitting machines, when the breaking of a thread allows a metallic arm to drop, and this comes in contact with a tongue, and makes a connection which turns a band on to a loose pulley or otherwise.

Fig. 1847.



Elec. Steam-Gage.

E-lec'tric Sig'nal. One in which visual, palpable, or audible signals, by simple or repetitive sounds or by code, are conveyed by electric influence. The motion of bell-hammers, of flags, index-fingers, or semaphoric arms may be held as included in this definition, which thus covers telegraphing and signaling by electric circuit.

By a not distant connection, storm-signals and time-balls of observatories may be held as included.

E-lec'tric Steam-gage. A steam-boiler attachment, in which the rise of the mercury under pressure of steam is indicated by means of electric connection to the dial. In the example, the galvanic battery and index are connected with the mercury column by means of insulated points on the tube, so that the index will signal each successive pound of pressure upon the dial, which has corresponding points. The completion of the circuit also sounds an alarm by attracting the armature on the hammer-shaft.

E-lec'tric Switch. A device for interrupting or dividing one circuit and transferring the current or a part of it to another circuit. See SWITCH. A *commutator.* See Culley's "Handbook of Telegraphy," London, 1870, pp. 199-203.

E-lec'tric Tel'e-graph. That form of electric signaling apparatus in which an insulated wire excited by frictional electricity is — or rather was — used to convey messages by sparks or shocks. For notices of early observations, see ELECTRICAL APPARATUS.

Gray, in 1729, experimented with conductors; Nollet soon afterwards sent a shock along a line of men and wires 900 toises in length; Watson, the learned Bishop of Llandaff, in 1745, sent a shock through 12,000 feet of wire, and proved that it was practically instantaneous throughout its length. He signaled an observer by this means.

A writer in the "Scots' Magazine," in 1753, proposed a series of wires from the ends of which were to be suspended light balls marked with the letters of the alphabet, or bells which were to be moved by an electric current directed to the appropriate wire.

Lesage, at Geneva, in 1774, actually constructed a telegraph arranged in this manner, the end of each wire having a pith-ball electroscope attached.

Lamond, in 1787, employed a single wire, employing an electrical machine and electroscope in each of two rooms, and thus talking with Madame Lamond by the peculiar movements of the pith-balls according to an agreed code; and Reusser, in 1794, proposed the employment of letters formed by spaces cut out of parallel strips of tin-foil pasted on sheets of glass, which would appear luminous on the passage of the electric spark.

In 1795, Cavallo proposed to transmit letters and numbers by a combination of sparks and pauses.

Don Silva, in Spain, appears to have previously suggested a similar process. See ELECTRICAL APPARATUS.

In 1816, Mr. Ronalds experimented with a frictional electricity telegraph at Hammersmith. The current had to pass through eight miles of wire, and the signals were made by means of light pith-balls. The reading was effected by dials at each station having a synchronous movement derived from clockwork. Upon their circumferences the letters of the alphabet were engraved, and a screen with a hole cut through it was arranged at each end of the line, so that only one letter should be visible at a time. The operator at the transmitting station waited until the letter he wanted came opposite the hole in the screen and then made the signal, causing the divergence of the pith-balls at the instant that the same letter became visible to the observer at the other station through the aperture in his screen.

Betancourt, in 1796, constructed a single-line telegraph between Madrid and Aranjuez, a distance of twenty-seven miles, in which the electricity was furnished by a battery of Leyden jars, and the reading effected by the divergence of pith-balls.

It was not, however, until the discoveries of Volta, Galvani, Oersted, Ampere, Faraday, and Henry elucidated the properties of electricity developed by the voltaic battery, that a practical, continuously working instrument was feasible. Following these discoveries came the practical instruments and codes of the no less illustrious Morse, Wheatstone, and others. See VOLTAIC PILE; GALVANIC BATTERY; ELECTRO-MAGNETIC TELEGRAPH.

E-lec′tric Time-ball. A balloon of canvas suspended on a mast, and dropped at an exact time every day by means of an electric circuit operated by an observer whose eye is upon the astronomical clock, and hand upon the telegraph-key.

E-lec′tric Torch. A gas-lighter operating by electric action. An *electrophorus*.

E-lec′tric Wand. An electrophorus in the shape of a baton. See ELECTROPHORUS.

E-lec′tric Watch-clock. A watchman's time-detector, in which a patrol touches a stud at such times during the night as may indicate his presence at that spot at the appointed hour. Touching the stud completes an electric connection and makes a mark upon a traveling time-paper.

E-lec′tric Weigh′ing-ap′pa-ra′tus. An attachment to a scale which comes in as an auxiliary to the eye in detecting the turn of the scale. The poise is shifted out on the beam, and as soon as it feels the tendency to rise the circuit is completed, and the point at which the poise stopped is indicated.

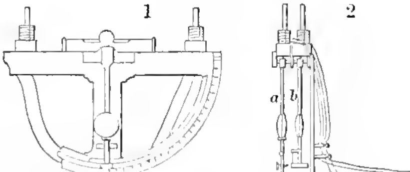
E-lec′tric Whal′ing-ap′pa-ra′tus. A means whereby a bursting-charge in a harpoon may be exploded. See ELECTRIC HARPOON.

E-lec′tro-bal-lis′tic Ap′pa-ra′tus. An instrument for determining by electricity the velocity of a projectile at any part of its flight.

The projectile passes through a wire screen, thus breaking a current of electricity, and setting in motion a pendulum, which is arrested on the passage of the projectile through a second screen. The distance between the screens being known, the arc through which the pendulum vibrates measures the time due to the projectile's flight between the screens. See CHRONOGRAPH; BALLISTIC PENDULUM.

E-lec′tro-bal-lis′tic Pen′du-lum. Fig. 1848 1 is an elevation and 2 a section of the apparatus used in the United States Ordnance Department.

Fig. 1848.



Electro-Ballistic Pendulum.

The pendulums *a b* are suspended from the same axis, and are so adjusted that when each is brought to a horizontal position at the 90° mark on each side of zero at the middle of the arc *c* and let fall, they will meet precisely at the center. The bob of the inner pendulum *b* is provided with a marking point, the outer end of which is struck by a blunt projection on the outer pendulum *a*, when the two pass each other, impressing a mark on a sheet of paper clamped to the arc. See CHRONOGRAPH.

E-lec′tro-blast′ing. Blasting by means of an electric or electro-magnetic battery, communicating through connecting wires with the charges of powder.

It was first tried in blowing up the sunken hull of the "Royal George," in 1839, by Colonel Pasley.

In 1840 the plan was used in Boston Harbor by Captain Paris.

In 1843, by Cubitt, for overthrowing a large section of Round-down Cliff, Kent, England, in making a portion of the Southeastern Railway. The mass dislodged weighed 400,000 tons. See BLASTING.

E-lec′tro-chem′i-cal Tel′e-graph. A telegraph which records signals upon paper imbued with a chemical solution, which is discharged or caused to change color by electric action.

Nicholson and Carlisle discovered, in 1800, that water was decomposed by the voltaic pile, hydrogen being evolved at the negative and oxygen at the positive end of the wire. Davy, afterwards Sir Humphry Davy, by the aid of the apparatus of the Royal Institution at London, the most powerful then in existence, proved by a series of experiments, commencing in 1801, that many substances hitherto considered as elementary bodies could be decomposed by voltaic action, and succeeded in 1807 in resolving the fixed alkalies soda and potash. Faraday, 1833, besides his extensive additions to the science of electro-magnetism, established the fact that the chemical power of a current of electricity is in direct proportion to the absolute quantity of electricity which passes; and farther proved that the quantities required for decomposing compound bodies were proportional to the atomic weights of Dalton.

Bain's telegraph (1845) was the first in which these scientific facts were so applied as to lead to any practical result.

In this, a solution of ferro-cyanide of potassium in water, to which are added two parts of nitric acid and two of water, is employed. With this long strips of paper are saturated, which being drawn between a metallic roller and stylus operated by means usual in electro-telegraphy, — dispensing, however, with relay-magnets, — dots and dashes are produced, as in the Morse system. These appear of a blue color, in consequence of the ferro-cyanide of potassium being converted into cyanide of iron by electric action and contact of the iron stylus with the paper.

Bakewell subsequently improved the construction of this instrument, and added an electro-magnetic governor, to obtain synchronism in the movements of the apparatus at the two ends of the line.

Gintl, a German, in his method, also dispenses with the relay, and records messages by the line-current direct. He prepares his paper with a solution of one part iodide potassium and twenty starch-paste in forty parts of water. The iodine being set free colors the starch blue.

Bonelli's telegraph (1860) records a fac-simile of the transmitted message on mechanically prepared paper. The message is set up in type, which are arranged in a box at one side of a carriage that traverses from end to end of a table, and passes back and forth under a bridge placed transversely thereto. The type occupy the lower left-hand side of the carriage, and at the upper right-hand side is placed a strip of the paper. Immediately over the type are five movable teeth, insulated from each other and connected by five wires with a similar number of styles at the receiving apparatus. As the carriage with the types face upwards comes under the bridge, the teeth come lightly in contact with their raised portions, closing the circuit so long as the metallic contact lasts. Thus letter after letter is transmitted. On the right side of the bridge is a writing-comb composed of five teeth made of platinum-iridium alloy, which is not subject to corrosion, insulated from each other and pressing lightly on the paper strip beneath. This would produce, if each tooth were simultaneously traversed by the electric current, five parallel lines on the paper; but as the current only passes to each during the time when some portion of a type is beneath the corresponding tooth of the type-comb at the sending station, they only produce lines at such intervals and of such length as are determined by the form of the type; cavities in the letters and spaces between letters and words being represented by the discontinuation of one or more of the lines.

The wagon is moved by a cord and weight, and is secured at one end of the carriage by a hook, which is released by an electro-magnet when a current is sent over the wires.

Those at each end of the line are adjusted to traverse their respective carriages in equal or nearly equal times.

The paper intended for receiving permanent printing is prepared by being saturated in a solution of nitrate of manganese, which, under the action of the current, leaves a light brown mark. Fugitive printing, as for the press, is done on paper prepared with iodide of potassium, which affords at first an iodine color, but is liable to fade.

It is said that a speed of 300 in permanent, and of 1200 words in fugitive, printing per minute is attainable by this apparatus. See ELECTRO-MAGNETIC TELEGRAPH: AUTOGRAPHIC TELEGRAPH.

E-lec'tro-chron'o-graph. An instrument used for recording time and occurrences in the instant and order of their time, as in noting transits in observatories. A paper marked for seconds is placed on the surface of a revolving drum, over which is a stylus operated by electro-magnetic action when the circuit is closed by the telegraph key in the hand of the operator, who is also the observer at the transit instrument. A mark is thus made on the time-paper at the instant of the occurrence of the transit.

E-lec'trode. Either of the poles of the voltaic circle. The positive, +, electrode is the *anode*; the negative, −, the *cathode*. The terms are Faraday's.

E-lec'tro-dy-nam'ic En'gine. An engine in which a dynamic effect is produced by the evolution of an electric current, by voltaic battery or otherwise. See ELECTRO-MAGNETIC MACHINE.

E-lec'tro-en-grav'ing. Engraving executed by means of electricity. A form of etching.

E-lec'tro-etch'ing. A process for biting-in an engraving by attaching it to the copper of the battery in an electro-bath. The plate is covered with a ground and etched in the usual manner; being immersed for a while in the bath, it is withdrawn and the fine lines *stopped-out*; a second immersion deepens the lines and makes the next tint, and so on.

E-lec'tro-gild'ing. A thin deposition of gold by voltaic action on an object placed in a bath of a salt of the metal. See ELECTRO-PLATING.

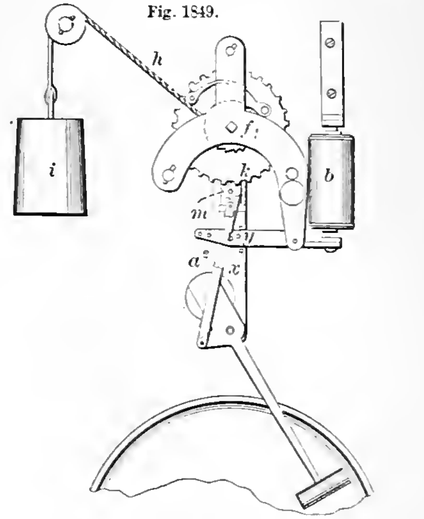
E-lec'tro-lyte. The compound in the electroplating bath which is decomposed by the electric action.

E-lec'tro-mag'net. A bar of soft iron rendered temporarily magnetic by the passage of a current of electricity through a coil of wire by which the bar is surrounded.

The electro-magnet of the Stevens Institute of Technology weighs in all about 1,600 pounds: eight brass spools, each of which is wound with 272 coils of copper wire insulated with *kerite*. The hollow spools contain cores of Norway iron, four to each core. The lifting-force of the magnet is from thirty to fifty tons.

E-lec'tro-mag-net'ic A-larm'. One which is brought into action by the closing an electro-magnetic circuit. This may be a burglar-alarm in which the opening of a door or window is made to close a circuit mechanically; or it may be a fire-alarm in which the lengthening of a rod or a change in its shape is made to close a circuit. In some cases, a column of mercury is expanded by the heat and thus completes the circuit, the coil *b* attracting the armature and releasing the detent of the wheel *k*, which is then revolved by the weight *i* and cord *h*, and

Fig. 1849.



Electro-Magnetic Alarm.

vibrates the hammer-shaft, delivering a blow upon the bell. By this means the hammer may be made to give a repetitive alarm, like that of a clock, as a warning, or the instrument may be used as a signal. each closing of the circuit by means of a key giving a single blow. See FIRE-ALARM.

E-lec'tro-mag-net'ic Clock. These clocks are of two kinds:—

Those in which the motive-power is derived from electric action. Invented by Wheatstone.

Those which are operated by the usual means, but are made the medium by mechanical devices of driving or regulating other clocks to which they are connected by an electric circuit.

1. In Bain's clock the pendulum, at each vibration, moves a light slide by which the electric circuit is alternately completed and broken, and by which magnetism is alternately conferred upon and abstracted from a coil inclosed in a heavy hollow brass case which constitutes the bob of the pendulum. On either side of the pendulum are the poles of two permanent magnets, which alternately attract and repel the coil of the bob, according to its magnetized or demagnetized condition.

A clock of this kind has been kept in motion by electric currents derived from a zinc plate buried in damp earth.

Shepherd's electro-magnetic clock was shown at the London Exposition, 1851. In this clock electro-magnetism is the sole motor in moving the pendulum, driving the train, and running the striking-works, no weights or auxiliary springs being employed.

The pendulum in its oscillations makes and breaks an electric circuit, which alternately magnetizes and demagnetizes a horseshoe-magnet, which in its active condition attracts an armature and raises a lever which is caught by a detent-latch. On the breaking of the circuit, the armature is released, the latch lifted, and the weighted lever strikes the pendulum to give an adequate impulse to maintain its motion. This is repeated at each oscillation.

Besides the circuit just described, which maintains its own action, the pendulum makes and unmakes another circuit which actuates a ratchet-wheel, propelling it at the rate of a tooth to each second, the axis of this ratchet-wheel operating the remainder of the train.

The circuit of the *striking* part is only completed once in an hour, and operates an armature to pull the ratchet-wheel attached to the notched striking-wheel one tooth forward every two seconds, and each tooth is accompanied by a blow on an electro-magnetic bell. The number of blows depends upon the notched wheel, the spaces in the circumference of which are adapted to the number to be struck; and when this is complete, a lever falls into the notch, and in so doing cuts off the electric circuit till the recurrent period again stirs the striking-parts into activity.

2. The other form of electro-magnetic clock is designed to obtain isochronous action among a number of clocks in different portions of a building or a town.

Fixed upon the arbor or axis of the second-wheel of a clock is a wheel of metal, the circumference of which is divided into sixty alternating divisions of metal and of ivory, the former being a conductor and the latter a nonconductor of electricity. A small platinum peg is kept in contact with this divided edge, so as, by the revolution of the wheel, to be alternately in contact with the conducting and nonconducting surfaces, and so connected with a voltaic series as to alternately admit and resist the passage of an electric current.

The electric circuit thus becoming pulsative is caused by local magnets and armatures to actuate an apparatus stationed at any point to which the wires may be carried, giving motion to a wheel and axle, and causing it to revolve so as to indicate seconds, and the other motion-work of a clock.

By this means isochronous pulsations of seconds are maintained at all the points connected with the regulator, and thus perfect uniformity is established at all the clocks of a city, capitol, or private establishment.

Dr. Locke of Cincinnati, about 1848, invented the method of obtaining isochronous vibration of pendulums by electric connection. Congress awarded him a premium of $10,000 for the invention, designing to use it in astronomical researches and determining longitudes.

E-lec'tro-mag-net'ic En'gine. The action of a current of electricity converts a piece of soft bar-iron into a magnet, and the breaking of the circuit restores the iron to an inert condition. This transition — alternate excitement and prostration — has been frequently utilized to confer a pulsative movement upon an armature, whose motion in one direction is obtained by the attraction of the magnet and the reflex action by a spring or weight in the intervals of electric excitement of the iron.

So far the chronicler has little to record of valuable effect derived from this engine, though its power is demonstrable. At present the authorities declare it is resolved into a question of the relative costs of zinc and coal. The case is thus stated in the "American Artisan": —

"The chemical action in the galvanic battery is the source of power in electro-magnetic engines, just as the rapid chemical action called combustion in the furnace of a steam-engine is the source of power there. Chemical affinity, or the tendency of two bodies to combine chemically, is a sort of potential energy which, when the substances actually do combine, is replaced by actual energy in the form of heat or of current electricity, or of both combined; and this may be converted into mechanical energy. In a Daniells battery, the liquid in the cells being a solution of a sulphate of copper in water, the total heat produced by the solution of one pound of zinc is 3,006 thermal units; 2,342 being produced by the oxidation of the zinc, and 664 being produced by the combination of the oxide of zinc with sulphuric acid. The total heat consumed is 1,419 thermal units; 527 being consumed in decomposing sulphate of oxide of copper, and 1,060 being consumed in decomposing the oxide of copper. The total quantity of heat developed is, therefore, 3,006 less 1,587, equal to 1,419 thermal units; and this quantity multiplied by 772 foot-pounds, the mechanical equivalent of heat, gives 1,095,468 foot-pounds for the amount of energy developed by the solution of one pound of zinc in a Daniells battery. This is less than the total energy developed by the combustion of one pound of carbon. In a Smee's battery, the liquid in the cells being dilute sulphuric acid, the heat produced by the combination of one pound of zinc with oxygen and sulphuric acid is, as before, 3,006 thermal units, and the total heat consumed is 2,106 thermal units; about 200 being consumed in separating water from sulphuric acid, and 1,906 being consumed in decomposing water. The total amount of heat developed, therefore, is 3,206 less 2,106, equal to 900 thermal units, which are equivalent to 694,800 foot-pounds of mechanical energy derived from the solution of one pound of zinc in a Smee's battery. This is about one sixteenth part of the energy developed by burning one pound of carbon. It is certain that the *efficiency* can be made to approximate much more nearly to *unity*, the limit of perfection, in electro-magnetic engines than in steam-engines. At present, however, the ratio of their efficiencies can only be roughly estimated; and it may be considered as a favorable view toward electro-magnetic engines to estimate their greatest possible efficiency as four times that of the best steam-engines. Taking this into account along with the previous calculations, and it appears that the work performed per pound of zinc may be estimated at four tenths of the work per pound of carbon in steam-engines when the solution used in the cells of the battery is sulphate of copper; and at four sixteenths, or one fourth, of the work per pound of carbon in steam-engines when dilute sulphuric acid is used in the cells of the battery.

"Before, therefore, electro-magnetic engines can become equally economical with heat engines as to cost of working, their working expense per pound of zinc consumed must fall until it is from four tenths to one quarter of the working expense of one of the most economical steam-engines per pound of carbon or of coal equivalent to carbon. The price of zinc, however, being so much greater than that of coal, it is evident from these facts and calculations that electro-magnetic engines never can come into general use except in cases where the power required is so small that the cost of material consumed is of no practical importance, and the situation of the machinery is such as to make it very desirable to have a prime mover without a furnace."

According to Mr. Joule, the consumption of a grain of zinc, though forty times more costly than a grain of coal, produces only about one eighth of the same mechanical effect.

Cazal's electro-magnetic machine resembles a fly-wheel, being a thick disk of soft iron cut into the shape of a gear-wheel and having a circumferential groove wound with insulated wire, whose ends are soldered to insulated thimbles, which, by means of tangent springs, introduce the battery current. Surrounding this magnetic wheel is a fixed, heavy iron ring insulated on its interior surface in a manner to present elevations corresponding to the teeth of the wheel. When the teeth of the wheel pass before the prominences of the ring, there is a near approach to contact, and the attraction is strong. The attractions are balanced when the teeth are midway. At the moment of nearest approach the current is arrested; it is renewed when the teeth are midway; the momentum of the wheel carries it over the point of equal attractions.

The Birmingham Company's (English) electromotor has four sets of fixed electro-magnets of the horseshoe form, two sets at each end of an oscillating beam by which the power is to be utilized. The magnets of each set are arranged in two tiers, one above the other. The armatures of these several magnets are carried by rods depending from the ends of the beam; but the rods pass freely through these armatures without being fastened to them. When, therefore, an armature, in the descent of the rod, comes into contact with the magnet to which it belongs, the rod continues its motion and leaves the armature resting there. In the return motion the rod lifts the armature again, by means of a collar or enlargement which has been given to it at the place intended.

In the action of the machine, the battery current actuates the magnets on the side of the descent, while on the other side the current is cut off. The machine acts, therefore, only by attraction. As the armatures approach their magnets successively, it happens that whenever one becomes inefficient, by coming into contact with its magnet, the next will be in position to exert a very high attractive force, and this force increases until this next makes contact with its magnet in like manner.

Kravogl's electro-magnetic engine is a heavy wrought-iron wheel rotated by the creeping up inside it of a permanent magnet, which displaces the center of gravity, and by the preponderance of the side rotates the wheel.

Another form of the engine has two powerful helixes of insulated copper wire, within which are two heavy cylinders of soft iron counterbalanced on the ends of a beam, like the working beam of a steam-engine. By the working of an eccentric on the main or fly-wheel shaft these insulated helixes are alternately connected and disconnected with the opposite sides of a galvanic battery so as to magnetize and demagnetize alternately the two helixes, and so drawing first one and then the other of the soft bar-iron cylinders into them with a force of many hundred pounds. In some machines of this description 10-horse power has been obtained.

Page's reciprocating engine (Fig. 1850) consisted of two electro-magnets, the armatures of which are connected by a bar moving upon centers, the bar is connected with the beam, which, by means of a crank, moves the fly-wheel; by means of a break-piece upon the axle of the fly-wheel, the current is alternately passed through the two magnets.

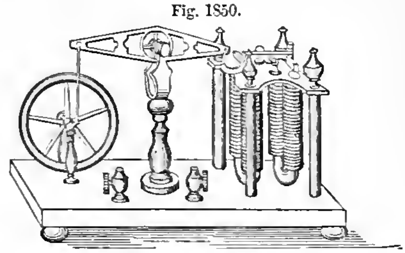
A double-beam engine of similar construction, operated by two pairs of electro-magnets, has also been made.

About 1849, Professor Page propelled a car on the track of the Baltimore and Washington Railroad from Washington to Bladensburg, a distance of six miles, and back, by means of an engine of his invention, attaining a speed of nineteen miles an hour.

Various forms of electro-magnetic engines have also been invented by Wheatstone, Talbot, Hearder, Hjorth, and others. Professor Jacobi of St. Petersburg, in 1838 – 39, succeeded in propelling a boat upon the Neva at the rate of four miles an hour, by means of a machine on this principle. The boat was 28 feet long, about 7 feet wide, drew about 3 feet water. The battery used consisted of sixty-four pairs of plates, and propelled the boat by paddle-wheels. He also applied his engine to working machinery, but without decided success.

In 1842, Davidson constructed an electro-magnetic locomotive-engine which attained a speed of about four miles an hour on the Edinburgh and Glasgow Railway.

Fig. 1850.



Page's Electro-Magnetic Engine.

E-lec'tro-mag-net'ic Ma-chine'. See ELECTRO-MAGNETIC ENGINE.

E-lec'tro-mag-net'ic Reg'u-la-tor. A device for maintaining an even heat in an apartment, a bath, or a furnace. See THERMOSTAT.

E-lec'tro-mag-net'ic Tel'e-graph. A signaling, writing, printing, or recording apparatus in which the impulses proceed from a magnetic force developed by voltaic electricity. A mass of soft iron is rendered temporarily magnetic by the passage of a current of electricity through a surrounding coil of wire. It differs from the *electric telegraph* properly considered, and also, specifically, from the MAGNETO-ELECTRIC TELEGRAPH (which see). See also list under TELEGRAPH.

Three discoveries necessarily preceded the invention of the electro-magnetic telegraph: the properties of the magnet, the modes of developing frictional electricity, and voltaic electricity. The earlier electric telegraphs were all what their name implies, and not *electro-magnetic*. See ELECTRIC TELEGRAPH.

To save repetition, reference is here made to MAGNET, ELECTRICITY, ELECTRIC TELEGRAPH, VOLTAIC PILE, GALVANIC BATTERY, for the precedent discoveries and inventions which are the foundation of the electro-magnetic telegraph.

In 1808, Sömmering described a system invented by him, based upon the decomposition of water by the voltaic pile, embracing a number of wires equal to that of the alphabet and the numerals, and leading into glass tubes containing water, the bubbles of gas from which, when the electric fluid was conducted into them, served as signals.

Professor Coxe, of Pennsylvania, about the same time suggested telegraphing by means of the decomposition of metallic salts.

Oersted, in 1820, after many years' research into the action of the voltaic current on magnets, announced the fact that the magnetic needle was deflected by such current, exhibiting a tendency to place itself at right angles to the wire through which the current passes; and Faraday discovered in 1821 that the magnet would revolve about the conducting wire, or the latter about the magnet.

The experiments of Oersted, farther extended by Ampère, and the discovery by Faraday that magnetism was induced in a bar of soft iron under the influence of a voltaic circuit, led the way to the invention of the first really convenient and practical system of electro-telegraphy.

In 1825, Mr. Sturgeon, of London, discovered that a soft iron bar, surrounded by a helix of wire, through which a voltaic current is passed, becomes magnetized, and continues so as long as the current is passing through the wire.

In 1832, Baron Schilling constructed a model of a telegraph which was to give signals by the deflection of a needle to the right or left.

One great practical difficulty was still to be overcome, the resistance of the transmitting wire to the comparatively feeble current engendered by the voltaic battery.

This was conquered by Professor Joseph Henry, now secretary of the Smithsonian Institution at Washington, who, in 1831, invented the form of magnet now generally used for telegraphic purposes, and discovered the principle of "*combination of circuits*, constituting the important invention of *receiving-magnet*, and the *relay* or *local battery*, as they are familiarly known in connection with Morse's telegraph. The effect of a combination of circuits is to enable a weak or exhausted current to bring into action and substitute for itself a fresh and powerful one. This is an essential condition to obtaining useful mechanical results from electricity itself, where a long circuit of conductors is used." — PRESCOTT, *History of the Electric Telegraph.*

In 1832, Professor Morse began to devote his attention to the subject of telegraphy; and in that year, while on his passage home from Europe, invented the form of telegraph since so well known as "Morse's."

A short line worked on his plan was set up in 1835, though it was not until June 20, 1840, that he obtained his first patent, and nearly four years elapsed before means could be procured, which were finally granted by the government of the United States, to test its practical working over a line of any length; though he had as early as 1837 endeavored to induce Congress to appropriate a sum of money sufficient to construct a line between Washington and Baltimore.

Professor Morse deserves high honor for the ingenious manner in which he availed himself of scientific discoveries previously made by others, for many important discoveries of his own, and for the courage and perseverance which he manifested, in endeavoring to render his system of practical utility to mankind by bringing it prominently to the notice of the public; and he lived to see it adopted in its essential features throughout the civilized world.

In the mean while Gauss and Weber, and after them Steinheil, in Germany, were at work, and constructed a short line between the Royal Academy at Munich and the observatory; this, by means of right and left hand deflection-needles, was caused to print dots on a continuous slip of paper, moved by clock-work.

While making experiments in connection with this work, Steinheil made the important discovery that the earth might be used as a part of the circuit, thus enabling him to dispense with one half the length of wire which was thought requisite.

The attention of Wheatstone, in England, appears to have been drawn to the subject of telegraphy in 1834.

Morse's first idea was to employ chemical agencies for recording the signals, but he subsequently abandoned this for an apparatus which simply marked on strips of paper the dots and dashes composing his alphabet. The paper itself is now generally dispensed with, at least in this country, and the signals read by sound, — a practice which conduces to accuracy in transmission, as the ear is found less liable to mistake the duration and succession of sounds than the eye to read a series of marks on paper.

Bain, in 1846, patented the electro-chemical telegraph which dispensed with the relay-magnet at intermediate stations; and subsequently Gintl, in Austria, and Bonelli, constructed telegraphs of this class, varying in details from that of Bain. See ELECTRO-CHEMICAL TELEGRAPH.

Wheatstone's first telegraph comprised five pointing needles and as many line wires, requiring the deflection of two of the needles to indicate each letter.

His first dial instrument was patented in 1840; modifications were, however, subsequently made in it. The transmission of messages was effected by a wheel having fifteen teeth and as many inter-spaces, each representing a letter of the alphabet or a numeral, and thirty spokes corresponding to these, and forming a part of the line. The circuit was closed by two diametrically opposite springs, so arranged that when one was in contact with a tooth the other was opposite a space, when the transmitter was turned until opposite a particular letter, and held there, a continuous current being produced, causing an index on the indicating dial at the other end of the line, which had thirty divisions, corresponding to those of the transmitter, to turn until it arrived opposite the letter to be indicated. The revolution of the index was effected by clock-work, the escapement of which was actuated by an electro-magnet at either end of a pivoted beam, the ends of which carried two soft-iron armatures. One of the line wires, as well as one of the contact springs of the transmitter, and one of the electro-magnets of the indicator, was afterwards dispensed with.

A magneto-electric apparatus was subsequently substituted for the voltaic battery.

The single-needle telegraph of Cook and Wheatstone is caused to indicate the letters and figures by means of the deflections to the right or left of a vertical pointer; for instance, the letter A is indicated by two deflections to the left, N by two deflections to the right, I by three consecutive deflections to the right, and then one to the left, and so on. This is extensively employed in Great Britain and in India.

The same inventors have also contrived a double needle-telegraph on the same plan; but this, as it requires two lines of wire, each needle being independent of the other, though greatly increasing the speed with which messages may be transmitted, has not come into general use.

Dr. Siemens, of Berlin, invented an apparatus by which the armatures of the electro-magnets at each end of the line were caused to vibrate synchronously, maintaining the motion of scape-wheels carrying pointers traversing a lettered dial, so that, the vibrations of either armature being checked, the pointers at either end of the line would simultaneously point to the same letter.

House, about 1845, invented a telegraph which printed the letters of the Roman alphabet on a strip of paper, and was at one time extensively used in the United States. It comprised a lettered disk, operated in much the same way as that of Wheatstone, from keys arranged like those of a piano, and a receiving-apparatus, which included a scape-wheel, an anchor escapement, controlled by the movements of the lettered disk, and actuating a slide-valve which operated the piston of a compressed-air cylinder by which a wheel carrying type on its periphery was turned so as to present the appropriate letter indicated at the transmitting station to the paper slip which was by suitable mechanism drawn to the type-wheel to receive an impression.

Professor Hughes has also invented a very ingenious printing-telegraph, depending upon the synchronous revolutions of two or more type-wheels at different stations. See PRINTING-TELEGRAPH.

Various forms of dials or pointer telegraphs have been devised by Breguet in France, Siemens and Halske and Kramer in Germany, and various improvements in the details of construction by numerous others which the limits of this article will not permit us even to refer to. See specific index under TELEGRAPH.

E-lec'tro-mag-net'ic Watch-clock. An apparatus consisting of a magnet, with a recording-dial, clock-works, and a signal-bell; from this run wires, one to each of the banks or other offices under guard where watchmen are employed, whose duty it is to visit each bank at stated times during the night and give signals, which are recorded on the dial of the clock in the fire-alarm office, showing the time that the signal was given from any particular bank or office.

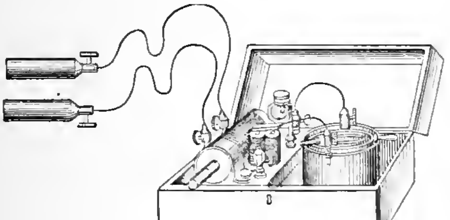
If the signal is not given within five minutes after the appointed time, the man on duty at the fire-alarm office communicates with the office of the superintendent of police, and an officer is immediately despatched to the point from whence no signal has been sent.

E-lec'tro-med'i-cal Ap'pa-ra'tus. An instrument for the treatment of diseases by electro-magnetism.

Great success in this line was announced by Johannes Francisco Pavate, at Venice, in 1747. The details of the apparatus employed by him are not known.

From that time to the present the treatment of diseases by electrical appliances has undergone its

Fig. 1851.



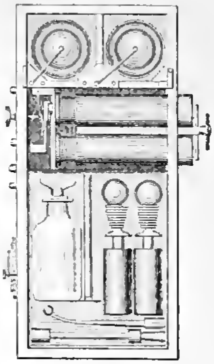
Electro-Medical Apparatus.

vicissitudes in public favor, becoming notably prominent after the discovery of voltaic electricity and of the properties of electro-magnetism. The latter is now generally adopted.

Fig. 1851 shows a machine designed for medical purposes. It is operated by a single-cell Daniells battery, the current from which, after passing through a helix, is conducted by wires provided with insulating handles to any part of the person to which it is desired to apply the treatment.

In the instrument shown in Fig. 1852 two small coils, connected with each other and furnished with a vibrating contact-breaker, are traversed by the currents from a small battery. The coils are surrounded by hollow cylinders of copper or brass in which induced currents are generated. These may be slipped on or off the coils, to intensify or moderate the strength of the current, which is directed by appropriate wires to the parts under treatment.

Fig 1852



Electro-Medical Machine.

E-lec-trom'e-ter. An instrument to measure the amount of an electrical force.

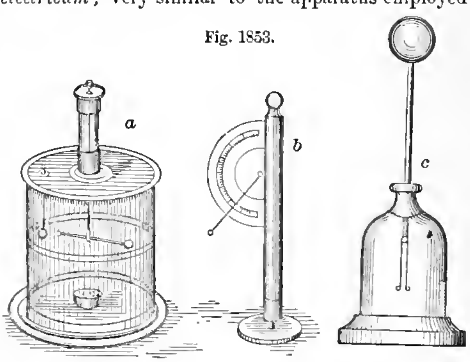
In Coulomb's torsion electrometer (*a*) the force opposed to that of electricity is the resistance to twisting offered by an elastic thread.

In Henly's quadrant electrometer (*b*) the electric force is measured by the amount of repulsion which it produces upon a pith-ball attached to a silk fiber suspended from the center of a graduated arc.

c is the gold-leaf electroscope. See ELECTROSCOPE. Sir William Thomson's and Varley's electrometers are the most delicate of all, and are used in reading the insulating power of telegraph-cables. See GALVANOMETER.

The strength of the electric force excited by the rubbing of glass, sulphur, amber, wax, resin, etc., was measured by Gilbert by means of an iron needle (not very small) moving freely on a point, *versorium electricum;* very similar to the apparatus employed

Fig. 1853.



Electrometers.

by Haüy and Brewster, in trying the electricity excited in different minerals by warmth and friction.

E-lec'tro-mo'tor. An exciter of electric action.

An apparatus actuated by electricity and imparting motion to a machine. See ELECTRO-MAGNETIC MACHINE.

E-lec'tro-neg'a-tive. Having the property of being attracted by an electro-positive body, or a tendency to pass to the positive pole in electrolysis.

E-lec'tro-nome. A measurer of electricity. See ELECTROMETER.

E-lec-troph'o-rus. An instrument invented by Volta, for generating electricity by induction, about 1776.

Volta's electrophorus (*A*, Fig. 1854) consisted of a thick disk of resin 12 or 15 inches in diameter, called the *plate*, resting on a tin foil called the *sole*. The plate has a metallic cover, insulated by a glass handle.

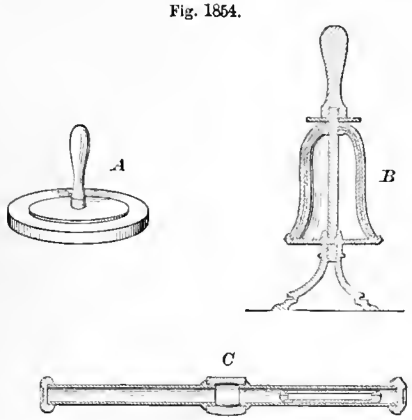
The resinous plate being excited by rubbing it with a warm and dry flannel, the metallic cover is placed upon it, and a spark of − electricity may be drawn from it; if it then be raised, it affords a spark of + electricity. On replacing the cover and again touching it, it affords another spark of − electricity, and so on.

It forms a portable electrifying-machine, and is used as a gas-lighter by developing a spark over the burner, inflaming the issuing gas.

The electrophorus *B* has a metallic bell lined with fur or wool, and a hard-rubber handle. It has also an interior bell of hard rubber with a metallic pedestal and foot. The act of raising the metallic bell generates frictional electricity, and the bell being brought into contact with an insulated chain attached to a burner develops a spark over the latter, thus lighting the gas.

In the electric wand *C*, the electricity is generated by a metallic tube sliding in a fur-lined reservoir of hard rubber, and is applied, as the bell just described, by establishing a circuit except at a short break over which the spark jumps.

Fig. 1854.



Electrophorus.

Another wand carries a Leyden jar.

E-lec′tro-pho-to-mi-cog′ra-phy. The art of photographing objects as magnified by the microscope by the help of the electric light.

E-lec′tro-plat′ing. A means of covering a metal or a metallic surface by exposure in a bath of a solution of a metallic salt, which is decomposed by electrolytic action.

Early in the present century, Volta demonstrated that a solution of a metallic salt, under the influence of the voltaic pile, became immediately reduced to its elements, in such a way that the metal was deposited at the negative pole. This was regarded as an interesting fact, of some moment to electricians, but not of special interest in the arts.

"Some curious experiments have lately been made by Mr. Cruickshank of Woolwich. On passing the galvanic influence by means of two silver wires through a solution of nitrat of silver, the upper wire became oxidated and gradually corroded, while at the same time a beautiful arborescent precipitation of metallic silver took place on the lower wire. Acetite of lead and sulphat of copper were similarly decomposed and precipitated on the lower wire." — *Monthly Magazine*, August, 1800.

In 1801, Wallaston demonstrated that a piece of silver in connection with a more positive metal placed in a bath of sulphate of copper became covered with copper and would stand burnishing.

It was not until 1838 that Mr. Spencer gave it a practical bearing by making casts of coin and casts in intaglio from the matrices thus formed.

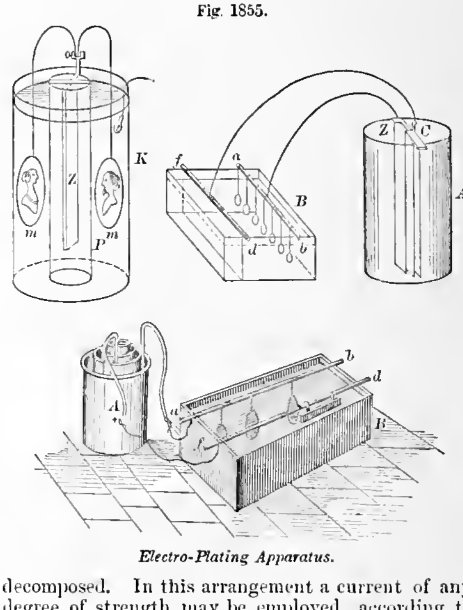
Professor Jacobi of Dorpat, in Russia, had been an independent inventor, and in the same year brought forward specimens which were much admired and caused him to be put in charge of gilding the iron dome of the Cathedral of St. Isaac at St. Petersburg. This dome weighs about 448,000 pounds, and was electro-gilded with 274 pounds of ducat gold.

The process, briefly described, is as follows: —

The voltaic current employed is supplied by a constant battery, such as Daniells's or Bunsen's. In the simple form, the galvanic current is produced in the same vessel in which the metallic deposit is effected. The outer vessel *K* of glass, stone-ware, or wood, contains a solution of the metallic salt, — say sulphate of copper. A smaller vessel *P*, of unglazed porcelain, contains diluted sulphuric acid. A plate of zinc *Z*, forming the positive pole, is suspended in the acid solution and connected with the copper medals *m m* by means of a copper wire. Electrolysis ensues, the copper in the solution is deposited on the medal which forms the negative pole, and the strength of the solution is maintained by suspending a bag of crystals of sulphate of copper in the bath.

In the compound form the galvanic current is produced outside the bath containing the solution to be

Fig. 1855.



Electro-Plating Apparatus.

decomposed. In this arrangement a current of any degree of strength may be employed, according to the size and number of cells forming the battery. *A* is the battery, *B* the vessel into which the solution of the metal to be deposited is placed; the molds are suspended from a metallic rod *a b*, opposite to which the plate *f d* is hung; copper, if the solution is a salt of that metal, will serve as a soluble electrode, and will be dissolved in the same ratio as the metal is deposited upon the mold. The battery being charged, *f d* is put into communication with the copper pole *C* by a copper wire, and *a b* is put in communication with the zinc pole *Z*.

The voltaic current being passed through the solution of a metal, decomposition takes place, the metal being electro-positive attaches itself in a metallic state to the negative pole or to the object attached thereto, — the medal, for instance, — while the oxygen or other electro-negative element seeks the positive pole.

The *anode* is the electrode placed at the positive pole of the battery, which in the electro-chemical decomposition can be dissolved, or which, if it be insoluble, attracts oxygen and acids. The *cathode* is the electrode which, placed at the positive pole, receives the metallic deposit, or attracts hydrogen and alkalies.

If the article to be coated be a medal or other object which is a conductor of electricity, the deposit will be made directly upon it; but if it be an engraved wooden block, a wax seal, or a plaster-cast, it is necessary to give it a conducting surface, which is done by brushing it over with black lead or bronze powder.

In obtaining the counterpart of a medal or engraved plate, the latter must necessarily be coated with some substance to prevent adhesion of the matrix. In the United States Coast Survey a solution of iodine is employed in the duplication of its copper-plates.

In Shaffner's process, wood, fabric, or fiber is prepared to receive a metallic coating by immersion in a bath containing plumbago in suspension.

Fibrous substances may also be prepared by dipping in a solution of nitrate of silver and ammonia, and exposure to hydrogen gas.

The process of electro-plating has been applied to many substances, as terra-cotta, wood, cloth, lace; and to the ornamentation of book-covers and similar objects; and also for soldering, by uniting the adjacent edges of two pieces of metal by forming a solid mass between them. The works of a chronometer watch have been electro-plated while going.

When applied to depositing a coat of silver or gold upon an article, it is placed in a solution of the required metal, the acid set free in the reaction being such as will act upon the piece of metal whose function it is to keep the metallic solution to its normal strength. Copper and its alloys and German silver are the metals upon which gold or silver are most readily deposited.

Electro-plating with iron has been done in Russia by a process invented by Jacobi and Klein; it is much more durable than copper, and is said to afford good results, having been used by the Russian government for printing bank-notes. A United States patent was granted for this process in 1868. See also Garnier's process, "Photographic Journal," Vol. VI., p. 31 *et seq.*

An important improvement in electro-plating is that of M. Oudry of Auteuil, near Paris, for coating large objects made of iron with a thick layer of copper. In the old process it was customary to clean the pieces to be plated, and after subjecting them to a weak preliminary bath, in order to form a thin film on the surface, to transfer them to a stronger bath, where they were subjected to voltaic action for several days. In this part of the process it was found that, owing to the strength of the acid bath, and the imperfection of the preliminary coating, the iron was corroded, instead of becoming coated with copper.

The details of M. Oudry's process have not been made public, but as a preliminary to the plating the articles are covered with three coats of benzine and afterward rubbed with pulverized charcoal, when they are ready for the bath, which is composed of a saturated solution of sulphate of copper.

The battery used is Daniell's.

The operation requires from three to four days, by which time a deposit about one twenty-fifth of an inch in thickness is formed. The objects, when removed from the bath, are washed in slightly acidulated water, brushed with a wire brush, and rubbed with paper to brighten them, after which they are brushed with ammoniacal acetate of copper, and finally polished with a hard brush well waxed.

By this process many of the cast-iron monuments in the city of Paris have been copper-plated, and also the street lamp-posts. Cast-iron lamp-posts weighing 4½ cwt. plated in this way cost about $40, while those of bronze of similar pattern, though weighing but 2¾ cwt., cost $150.

Herr W. Licke, of Hanover, deprecates the use of the acid bath, and advocates the use of a tartrate with either a soda or a potash salt, especially for coppering iron by means of galvanism. The best results were obtained with a solution of 20 parts of crystallized sulphate of copper in 160 parts of water, which solution is mixed with 50 parts of neutral tartrate of potash dissolved in 650 parts of caustic soda solution of 1.12 specific gravity.

E-lec'tro-po'i-on-bat'ter-y. (*Elektron-poiëo*, Gr., electricity-making.) A name applied specially to Bunsen's carbon battery, though applicable to other forms.

E-lec'tro-pos'i-tive. Having a tendency to the negative pole of a magnet or battery.

E-lec'tro-punct'ur-ing. Treatment by the insertion of needles in the body, and passing a voltaic current between the points.

E-lec'tro-scope. An instrument for detecting electrical excitation. It is shown at *c*, Fig. 1853, and consists of a glass jar with a wooden bottom, a brass wire passing through the cork and surmounted by a ball of the same metal; to the lower end of the wire are gummed two depending strips of gold-leaf. The test of the electric condition of a body is to bring a small ball suspended from a filament of silk against the body, and then apply the same ball to the knob of the electroscope. The presence of electricity will be shown by the divergence of the leaves, which, being similarly electrified, will repulse each other. A rod of glass or of sealing-wax rubbed and applied to the knob will determine whether the previous excitation was positive or negative.

The dry-pile electroscope consisted of a gold-leaf suspended between two balls, and Grove improved on this by insulating the gold-leaf between two surfaces and charging it at the same time by an electrified rod. See ELECTROMETER.

E-lec'tro-tint. A mode of engraving in which the design is drawn on a copper plate with an acid-resisting varnish. By the electro-bath a reverse is obtained, and from this copies are printed. The process may be adapted to relief or to plate printing.

E-lec'tro-type. A copy, usually in copper, of a form of type. An electrotype is superior to a stereotype, as copper is harder and more durable than type-metal, and the plates take less room in storage.

A page of the type is covered with wax, which is driven into the interstices by powerful pressure. The face of the wax-mold is covered with plumbago to give it a metallic surface to which the metal will adhere. The positive pole of a battery is attached to the mold, and the negative to a copper plate, and both are plunged in a bath of sulphate of copper in solution. The copper is deposited on the face of the mold in a thin film, which increases in thickness as the process continues. The *shell* having attained the thickness of a stout sheet of paper, the mold is removed from the bath, the shell detached, and strengthened by a backing of type-metal.

This process is called *backing-up*. As type-metal will not readily adhere to copper, the back of the shell is coated with tin, and the *shell* is then placed face downward on a plate, by which it is suspended over a bath of molten type-metal. When it has attained the requisite heat, a quantity of the metal is dipped up and floated over the back of the shell.

When cold, the plate is reduced to an even thickness by a planing-machine. For printing, it is mounted on a wooden backing.

Another mode of obtaining electrotype plates from a letter-press form is by a mold of gutta-percha, brushed with graphite and immersed in the electroplating bath.

Gutta-percha is also used for obtaining intaglio molds and then cameo impressions from woodcuts, for printing. See ELECTRO-PLATING.

E-lec′tro-typ′o-graph′ic Ma-chine′. An apparatus invented by Fontaine, a French barrister, for printing short legal documents, etc.

The letters of the alphabet — caps, lower-case, figures, etc. — are arranged around two horizontal disks, one above the other, and surmounted by a third disk which has notches corresponding to the types below. A bar in the center is caused to press upon the notch representing any particular letter, which is, by electro-magnetic action, caused to drop and leave its impression on a sheet of paper wound upon a roller beneath, and then return to its place.

When the whole has been printed, letter by letter, in this way, an impression is transferred to a lithographic stone, from which any number of copies may be printed.

E-lec′trum. 1. Argentiferous gold : an alloy of gold and silver.

A vase and eight drinking-cups of this material were found in an ancient Scythian tomb at Kertch.

2. An alloy of copper, zinc, and nickel : German-silver. See ALLOY.

El′e-phant. A size of drawing-paper measuring 28 × 23 inches, and weighing 72 pounds to the ream.

A flat writing-paper of about the same dimensions.

El′e-vat′ed Bat′ter-y. One which has its whole parapet elevated above the natural surface of the ground ; to procure the mass of earth required, a ditch is usually dug directly in front of the parapet.

El′e-vat′ed Ov′en. One whose baking-chamber is situated above that plate of the stove in which are the holes for the pots and kettles.

El′e-vat′ed Rail′way. A railway with an elevated track.

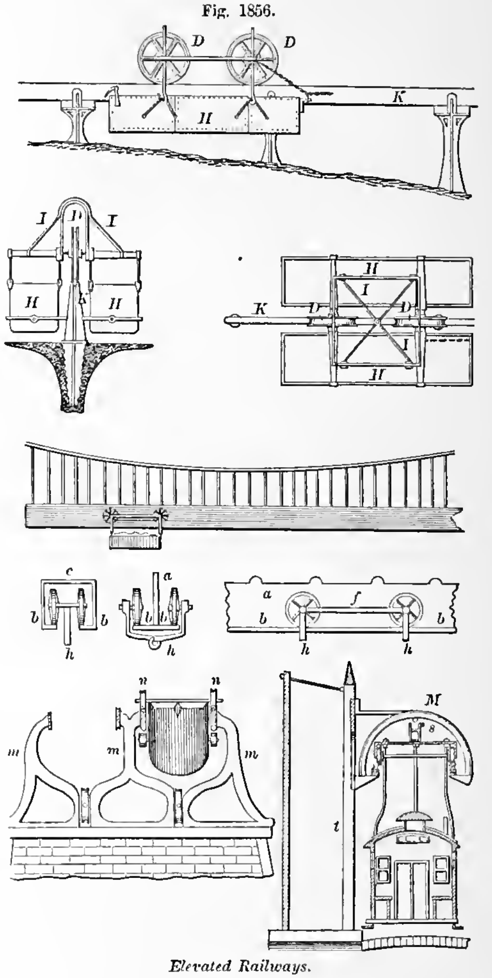
Any railroad supported on a continuous viaduct may be said to be an elevated railway, but the term has lately received a rather more limited application. It is now particularly applied to city railroads whose track is so elevated as not to materially infringe upon the street area, already too limited for the convenience of the citizens and the traffic.

The necessities for more convenient transportation of passengers in New York City, especially on Broadway, have perhaps given the greatest stimulus to invention in this line, and the question of elevated railway *versus* subterranean railway has been very thoroughly debated.

The capitals and other large cities of the world were not originally laid out for the modern means of locomotion. We see in the cities of Asia the condition which formerly existed in European towns, — narrow streets without sidewalks, adapted for pedestrians, equestrians, pack-animals, and sedan-chairs. Jeddo, Macao, and other Asiatic cities where the natives are yet dominant, have in general no provision for wheeled vehicles, and London before the great fire of 1666 was in much the same condition. The foot-traveler was jostled by the horseman, and stood on one side to let the train of pack-animals go by, just as the modern traveler resigns the road in favor of the loaded camel or the ambling donkey in the streets of Alexandria. The sedan-chair of England and the palanquin of Constantinople were carried by shambling porters, who were attended after nightfall by torch-bearers and guards, who illuminated the way and kept off the prowling robber. Asia, having stood still, preserves the institutions to which we have alluded ; Western Europe and the West have outgrown them some time since.

The topography of old Boston and Dutch New York show that no ideas of these modern stirring times troubled the engineers and architects of those days, and it has become a problem with their successors how best to adapt the thing as they find it to modern needs.

Fig. 1856.



Elevated Railways.

London has solved the problem by brick viaducts and subterranean railways, which are successful and safe ; of the latter it may be added, profitable.

New York, of all our American cities, is most interested in obtaining the best solution of the problem.

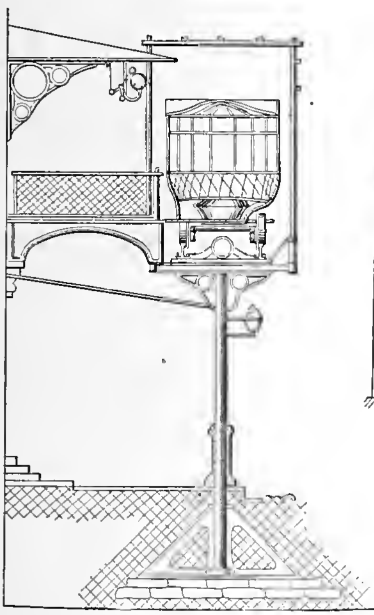
The viaduct of the London and Greenwich Railway is 3 miles and 60 chains in length ; being composed of over 1,000 yellow brick arches, 18 feet span, 22 feet high, 25 feet wide. It cost over $1,300,000 per mile, and has not proved a paying investment to the shareholders.

The London and Blackwall Railway is upon a continuous viaduct of brick arches, and is 3 miles 38 chains in length. It cost £1,083,951. The public are benefited more than those who built it.

These are two examples of elevated railways of a certain kind. The Greenwich Railway was always worked by locomotives. The Blackwall Railway was for many years worked by stationary engines and wire ropes.

In 1821, Palmer, engineer to the London Dock Company, patented a railway whose single track was elevated upon pillars, which were of such lengths as to bring the track to a level or moderate inclination, notwithstanding the inequalities in the surface of the ground. This is shown in the upper illustrations of Fig. 1856. The boxes *H* are in pairs, suspended on each side of the carriage, which travels upon a pair of grooved wheels *D*. The track *K* is supported on the pillars. The wheels are placed one before the other, and the axles are extended laterally so as to support the boxes by the suspension-rods *I*. The

Fig. 1857.



Barnum's Elevated Railway

center of gravity of the loaded boxes is below the level of the rail.

The carriages are hooked together, and are drawn by horses and a towing-rope.

A railway on this principle was constructed in 1825 at Cheshunt, in England, and used for conveying bricks across the marshes to the river Lea, where they were shipped.

Fisher's English patent, 1825, in the same figure, shows a suspended carriage between two lines of rail.

In the figure, the bar *a* with rail-flanges *b b* is shown suspended by rods from a catenary chain, which is supposed to be spanning a river or deep gulley.

The carriage *f* has two pairs of wheels which traverse upon the flanges *b b*, and support the bar *h* from which is suspended the freight.

One of the views shows a modification, in which the rails are flanges of a hollow box or trunk *c*, the lower side of the box having a continuous longitudinal slit, allowing the passage of the suspension-bar.

The mode of propulsion is probably by a wire or rope.

Dick's elevated railway (English patent, 1825) had a double track supported on vertical pillars *m m* of varying hight when crossing irregular surfaces, so as to preserve a level, or nearly so.

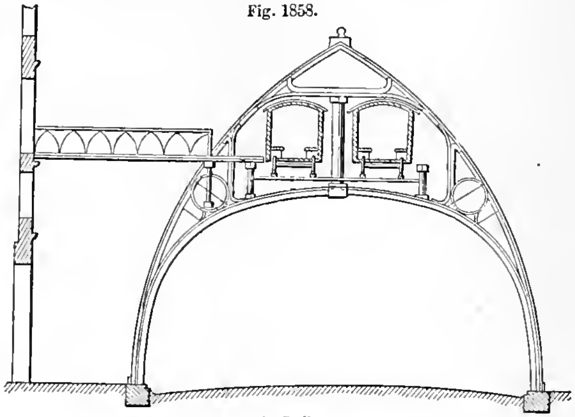
The track has two rails, upon which the wheels *n* of the carriage traverse; and beneath the rails are safety-wheels on the sides of the carriage, which keep the upper wheels from leaving, should the carriage sway and jump with high speeds.

The mode of propulsion was to be by drag-ropes from stationary engines. The lower wheels journaled between the sections of the supporting frame are for the ropes to run in.

Warren and Blume's elevated railway *M* is on the principle of the Fisher (English) patent of 1825.

The rails are supported upon inward projections at the spring of an arch *s*, which is attached by one end to a single post *t*. A truck runs on this track,

Fig. 1858.



Arcade Railway.

and the car is suspended from the truck, and is drawn by horses. The truck wheels have brakes which are operated from the car.

Fig. 1857 shows another form which is supported on columns and reached from the second floors of houses. It is driven by dummy-engine, compressed air, or by rope.

Another form is proposed to span the street and form an arcade. (Fig. 1858.)

Cheseborough's elevated railway consists of a series of inclined planes down which a car runs by its own gravity, elevating platforms being interposed to raise the car from the foot of one incline to the head of the next. The platforms are elevated by a perpendicular lift operated by compressed air.

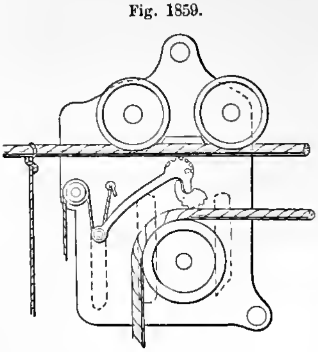
In India, Australia, and some other places, it has not been unusual to cross gullies and rivers by means of a bucket or basket suspended from a cord. The patents of Palmer, Fisher, and Dick, already cited, are an amplification of this idea, a carriage being arranged to travel on a rail.

The idea has recently been reduced to practice in a compact and useful form. See WIRE-WAY.

El'e-vat'ing-block. A tackle-block used in elevating hay or bales, where, after the object has been raised to a given hight, the block is required to travel along to a position above where the load is to be deposited.

The track-rope passes through the case under the

Fig. 1859.

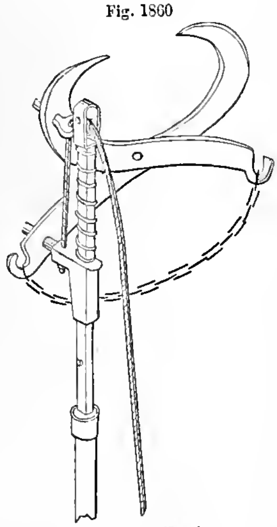


Elevating-Block.

locomotive pulleys. The draft-rope leading from the hay-fork to the team passes between the lower pulley and the stop. The cord running over the pulley in the rear operates the stop that rigidly connecting the draft to the track-rope above arrests its progress in either direction. It is managed by a depending check-rope, which is grasped by a man on the barn or warehouse floor.

El′e-vat′ing-clutch. Designed to attach a clutch to an elevated beam in a barn, as a means of suspension of the tackle of a horse hay-fork, and to detach the clutch therefrom when required. It has two arms attached to a handle of any suitable length, and arranged to engage the jaws of the clutch to hold them open until the beam is grasped or to unclose them when required.

Fig. 1860



Elevating-Clutch.

El′e-vat′ing-screw. One beneath the breech of a piece of ordnance, to give the elevation or vertical direction to the piece. In field-pieces it is bedded in the stock immediately under the base-ring of the gun, which rests on the top of the screw. The latter is turned by four handles.

In theodolites and other geodetical and astronomical instruments a similar contrivance is used for leveling the instrument. See also JACK-SCREW, etc. See list under HOISTING.

El′e-va′tion. 1. (*Astronomical Instruments.*) The arc of a vertical circle intercepted between an object and the horizon.

2. (*Dialing.*) The angle of the gnomon with its base.

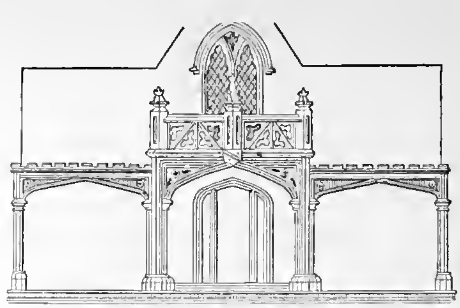
3. (*Gunnery.*) The angle of the line of fire with the plane of the horizon.

4. (*Drawing.*) A side or end view of an object or representation on a perpendicular plane.

An end or side view of a building or machine drawn according to the actual width and hight of its parts without reference to perspective.

Projections or depressions from the plane of the general surface are indicated by shadows equal in width to the depth of the elevation or depression, the light being supposed to fall at an angle of 45° both to the vertical and horizontal lines of the drawing, and usually from the upper and left-hand side.

Fig 1861.



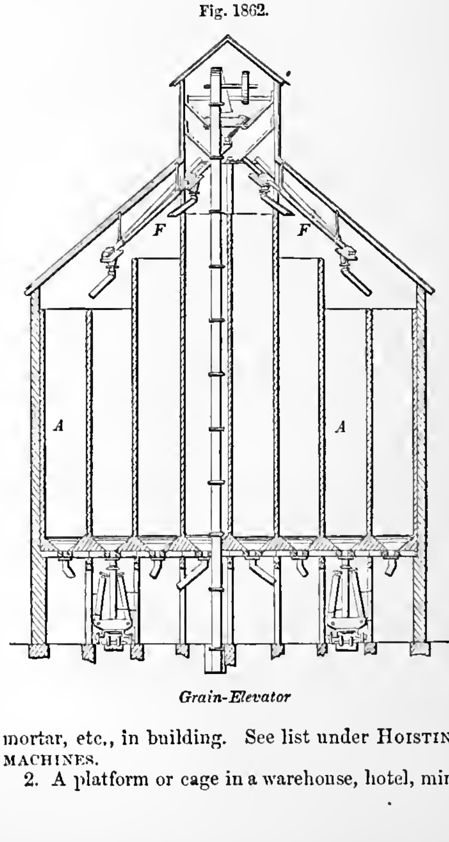
Elevation: — Porch and Veranda (Rural Gothic).

El′e-va′tor. 1. A machine for transferring grain by raising it from the car, a bin, or the hold of a ship, to an elevated hopper, whence it is discharged by any one of a series of spouts directed to a bin for storage or to the hold of a boat, a car, or to a run of stones.

Elevators are used in flour-mills to carry the wheat to the upper story, where it is cleaned in the smut-mill; also to raise wheat, so cleaned, to a bin whence it proceeds to the stones; also to raise the meal to the bolt, the offal to the bran-duster, etc., as the case may be.

Elevators are also used in many other machines for raising small objects or materials, such as the tailings in a thrashing-machine or clover-huller. These may be consulted where they occur under these heads. They are also used in elevating bricks, mortar, etc., in building. See list under HOISTING-MACHINES.

Fig. 1862.



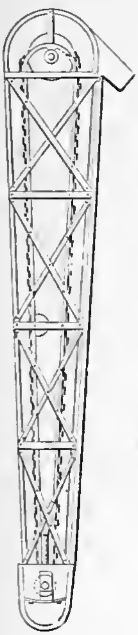
Grain-Elevator

2. A platform or cage in a warehouse, hotel, mine,

or elsewhere, for raising or lowering persons, goods, or material to or from different floors or levels. See HOIST; MAN-ENGINE; CAGE. Also the list above cited.

3. A building specially constructed for elevating, storing, and loading grain into cars or vessels. These structures are very capacious both as to the capacity for handling and storing, but the construction is very simple. An *elevator-leg*, so called, seen in Fig. 1863 and also in Fig. 1862, reaches into the bin or cellar into which the contents of the wagons or cars are discharged. A strong belt, carrying a series of buckets, travels over a drum at the lower end and also over one at the upper end, where the buckets tip over and discharge into the upper bin. This, as seen in Fig. 1862, has valved spouts *F* which direct the contents into either one of the deep bins *A*. The floors of these bins are over the tracks, and valves in the floor allow the contents of the bins to be discharged into cars or canal-boats, which are brought beneath.

Fig. 1863.



Elevator-Leg.

In unloading from ships, the leg is a pivoted, adjustable piece, which is first raised to obtain the necessary hight, brought over the hatchway, and lowered thereinto.

In practice, the grain is discharged into the hopper of a weighing-machine gaged exactly for one hundred bushels; by pulling on a valve the contents are sent by a spout to the bin, the valve closed, the elevating resumed, and so on. Seven thousand bushels an hour are thus weighed. An elevator at Milwaukee is 280 feet long and 80 feet wide. The total length of the great driving-belt, urged by a 200-horse-power engine, is 280 feet, that is, the half extending from cellar to comb is 140 feet, and the down half is of course equal to it. This belt is 36 inches wide and $\frac{3}{8}$ of an inch thick, and is made of six-ply or thicknesses of canvas, with sheets of india-rubber passed between and into them. It drives nine receiving elevators or belts set with buckets, each of which lifts the grain 140 feet. The buckets are made of thick tin, bound with hoop-iron, and are well riveted to the belt at intervals of fourteen inches; six inches across the mouth and eighteen inches long. When full, one contains a peck. They do not usually go up quite full, but, allowing for this, there are 100 pecks = 25 bushels, loaded on one side of one of these belts whenever it is at work. If all nine are running at once, as is often the case, the quantity of wheat lifted on these swift-running belts is 225 bushels. The established weight of a bushel of No. 2 Milwaukee Spring is 55 pounds. This would make the total lift of the receiving elevators during the time they are at work over 12,000 pounds.

The bins in which this wheat is poured are of great size, being 60 feet deep, 20 wide, and 10 across, containing 12,000 cubic feet. The total receiving and storing capacity of this building is 1,500,000 bushels. Of the crop of 1869 it received 7,000,000 bushels. About 10,000 bushels are taken into a train of the average length; so 2,100 trains were that year rolled into this elevator and discharged.

In discharging on to the Lake grain-vessels, as soon as a ship is anchored beside an elevator the hatches are removed and great spouts extend over them from the bottom of one of the bins described. The gate is raised, and a torrent of wheat pours down. The loading power of these spouts is 12,000 bushels an hour. A vessel with a capacity for 18,000 bushels may be loaded in an hour and a half. The Oswego and Ogdensburg schooners and vessels destined for the Welland Canal usually take on from 12,000 to 20,000 bushels. The Buffalo vessels are larger, often receiving 30,000, and in a few cases 45,000 bushels.

4. (*Surgical.*) An instrument employed in raising portions of bone which have been depressed, or for raising and detaching the portion of bone separated by the crown of the trepan. The common elevator is a mere lever, the end of which is somewhat bent and rough, in order that it may less readily slip away from the portion of bone to be raised. The elevator of Louis has a screw peg united to the bridge by a kind of pivot. Pettit's elevator is a straight lever, except at the very point, where it is slightly curved. The triploid elevator consists of three branches united in one common trunk.

The elevator is one of the instruments of the trephine case. A curved instrument for operating upon depressed portions of the skull was disinterred at Pompeii, 1819, by Dr. Cavenke of St. Petersburg.

El'e-va'tor-buck'et. One of the grain-cups on the traveling belt of the elevator.

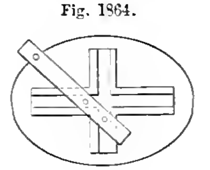
El'io-type. (*Photography.*) A mode of multiplying photographic copies of artists' work, patented by Eliot, England. The painting is made upon glass in a body-color more or less dense, and consequently more or less effective as a negative, and from it positives are printed.

El'i-qua'tion. The process of separating metals by exposure in a furnace or on a hearth to a heat which melts one and does not melt the other. See LIQUATION-FURNACE.

El-lip'so-graph. An instrument for describing ellipses. The pins of the beam traverse in the slots of the trammel, each occupying its own slot, and the pencil at the end, as the beam revolves, is guided in an elliptical path. See TRAMMEL.

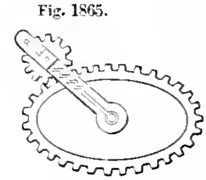
There are many varieties of compass for this purpose.

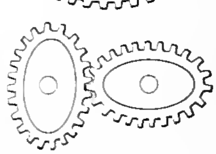
Fig. 1864.

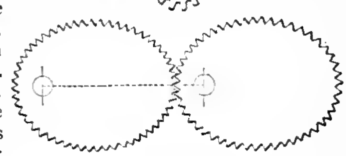


Ellipsograph.

Fig. 1865.







Elliptical Wheels.

El-lip'ti-cal-arch. (*Architecture.*) An arch having two foci and an elliptical contour. The arches of London Bridge are the finest elliptical arches in the world; the middle one has 152 feet span.

El-lip'ti-cal-gear'ing. See ELLIPTICAL-WHEEL.

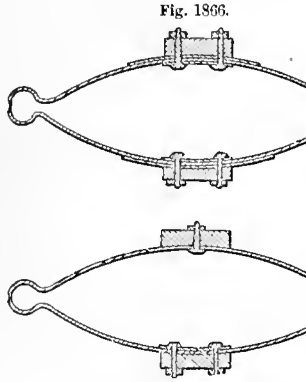
El-lip'ti-cal-wheel. One used where a rotary motion of varying speed is required, and the variation of speed is determined by the relation between the lengths of the major and minor axes of the ellipses.

In the upper figure, variable rotary motion is produced by uniform rotary motion. The small spur pinion works in a slot cut in the bar, which turns loosely upon the shaft of the elliptical gear. The pinion is kept to its engagement by a spring on the shaft. The slot in the bar allows for the variation of length of radius of the elliptical gear.

El-lip'tic-chuck. A chuck invented by Abraham Sharp, for oval or elliptic turning. See CHUCK.

El-lip'tic-spring. (*Vehicles.*) One formed of a number of bent plates in two sets, curved apart in the middle and united at the ends. The pressure is brought upon the middle and tends to collapse them.

Fig. 1866.



Elliptic Carriage-Spring.

In the illustrations, the spring is of one or two pieces, united by blocks or bolts.

E-lu'tri-a'tion. Purification by washing, when the water carries off a lighter or more soluble material from the heavier portion, which is designed to be saved. It differs from *lixiviation* in the latter respect.

To recover saccharine matter from animal charcoal, the latter may be *lixiviated*, water being passed through the mass to carry off the sugar.

To remove saccharine and coloring matters from starch in the process of manufacture, the material is *elutriated*, and the granules of starch settle in the bottom of the vat; the substances remaining in solution are removed by decantation.

El-y-dor'ic Paint'ing. A mode of painting invented by Vincent, of Montpelier, intended to combine the fresh appearance of water-colors and the mellowness of oil-painting. The vehicle for the pigments is an emulsion of oil and water with the intervention of a gum or mucilage.

Em. (*Printing.*) The square of the body of a type. As the "m" in early fonts had a square body, it became a unit of measure for compositors' work.

E-mail'-om'brant. A process which consists in flooding colored but transparent glasses over designs stamped in the body of earthenware or porcelain. A plane surface is thus produced, in which the cavities of the stamped design appear as shadows of various depths, the parts in highest relief coming nearest to the surface of the glass, and thus having the effect of the lights of the picture. Introduced by the Baron A. de Tremblay, of Melun.

Em-balm'ing. The art of preserving the dead bodies of men or animals. The earliest examples are found in Egypt, where it was practiced over 3000 years ago. There the custom was universal and intimately connected with their religion, as they believed in the resurrection of the body, and imagined that after the lapse of 3000 years the spirit would again inhabit its original tenement if the latter was still in existence. The invention was ascribed by them to Anubis the son of Osiris, who was said to have performed the office for his father.

It has been estimated that more than 420,000,000 mummies were embalmed between his time and the year 700 A. D., when the practice fell into disuse, besides an innumerable multitude of sacred animals, as dogs, cats, apes, ibises, bulls, rams, foxes, crocodiles, serpents, etc., which are found along with human mummies in the tombs.

The Egyptians, however, were not the only people who embalmed their dead. The practice prevailed, though not so extensively, among the nations of Asia, and was, at a somewhat later period, in use to some extent among the Greeks and Romans.

Herodotus gives a long description of the different methods employed by the ancient Egyptians. These varied according to the rank or wealth of the subject.

Drying the bodies in sand was a method chiefly practiced among the poorer classes; and it may be remarked that, in a warm dry climate like that of Egypt, decomposition does not take place so readily or speedily as in those which are favored with more moisture.

Embalming was also performed by salting in natron and then drying; boiling in resins and bitumen; and by removing the brain and viscera, washing with palm wine, and then applying fine resins, myrrh, cassia, and other aromatic substances.

In some cases oil of cedar was injected into the cavity of the body, which was then steeped in a solution of natron for 70 days, when the viscera came away, leaving little but skin and bone remaining.

Among the upper classes, the bodies, after being prepared, were swathed in linen bandages saturated with gum, the total length of which amounted in some instances to more than 1,000 yards.

The physicians embalmed Israel (Gen. l. 2) B. C. 1689, and the bodies of the Hebrew kings were embalmed with spices.

Within and about the bodies of different mummies have been found sulphate of soda, saltpeter, common salt, soda, oil of cedar, turpentine, asphalt, myrrh, cinnamon, and other substances.

The opinion has been advanced that an essential part of the process was the application of heat to the bodies, which were filled with some bituminous substance, by which means creosote was generated. As all mummy bandages were smeared with gum, and bear the appearance of having been heated, being often reduced to tinder, the production of creosote may have been the object for which they were gummed and partially calcined.

The cost of the most expensive method of embalming was a talent of silver, more than $1,100; according to Calmet, the prices ranged from the neighborhood of $300 to $1,500.

The principal materials used by the ancients (the Egyptians excepted) in embalming were honey, brine, wax, and vinegar.

Pharnaces put the body of his father, Mithridates, in brine, in order to preserve it during its transportation to Pompey. Several curious monsters and an ape were pickled and sent to Rome; Pliny and St. Jerome mention them. The body of St. Guibert was pickled to make it keep during a long journey in summer, A. D. 1113.

The bodies of several Grecian kings were preserved in honey. Agesipolis, who died in Macedonia, was thus sent home to Sparta. Alexander is said to have been sent to Egypt in honey; by others, to have been embalmed in Egyptian style. Perhaps he went to Alexandria in honey, and was then embalmed in regular order. The Emperor Julian II. was placed in honey mixed with spices.

Wax and waxen cerecloth were used for centuries in England. The body of one of the Edwards, interred 1307 and exhumed 1774, was preserved in natural shape, but fragile.

The body of Lord Nelson was sent to England in a puncheon of rum. The sailors ran foul of the cask, and, getting drunk, playfully called it "tapping the admiral." The poor man was nearly dry by the time he reached home.

The Scythians, Assyrians, and Persians used wax. The body of Agesilaus was covered with wax, but the practice soon became general of wrapping in waxed cloths. We read of these cerements in the preparation for burial of Philip of Burgundy, 1404; Edward I. of England, 1307; and George II. The cerecloth and aromatics for the latter cost £152.

John Hunter (died 1793) embalmed several bodies by injection into the arteries and veins. The bodies are preserved in the Museum of the College of Surgeons, London.

The Khasias, a people of the Himalayas, preserve the bodies of their dead in honey till the cessation of the periodical rains permits their being burned. The quantity of rain which falls in that region is remarkable. See RAIN-GAGE.

Embalming was practiced by the Guanches, or aboriginal inhabitants of the Canary Islands, and by the ancient Peruvians. Mummies from the latter source are now to be seen in the museum of the Smithsonian Institution. Some bodies have been preserved for ages by burial in caverns, the earthen floors of which contained a notable quantity of saltpeter. The steepes of Tartary, some of the uplands of Montana and Colorado, and the dry uplands of the Andes, are nitrous. Many caves are so also, the Mammoth Cave of Kentucky, for instance.

In very recent times, with the increase of chemical knowledge, considerable attention has been devoted to the subject, and various processes and compounds have been devised.

Dr. Chausier employed a solution of corrosive sublimate, with which the corpse, previously disembowelled and cleansed, is saturated; this imparts firmness to the flesh and renders it imputrescent.

Gaural practiced injecting the veins with sulphate of alumina.

Dr. Ure proposes chloride of mercury and wood vinegar to be used in a similar way. M. Falconi found that sulphate of zinc, injected into a body, would preserve it in a flexible condition for some six weeks, after which it began to dry up, though still preserving its natural color. Chloride of zinc and sulphate of soda are also sometimes used.

A more simple form of preparation for injection, well suited for anatomical purposes, consists of glycerine, 14 parts; soft sugar, 2 parts; nitrate of potash, 1 part. It is found that, after saturation for some days in this solution, the parts become comparatively indestructible, and change neither in size nor figure.

Dr. Hutton's (1863) composition is 4 pounds of zinc dissolved in 6 pounds muriatic acid, to which are added 1 gallon alcohol, 2 drams arsenic, and 1 dram corrosive sublimate; the fluid is injected into the arteries in a heated state.

Dr. Morgan's (English, 1864) is 6 pounds common salt, $1\frac{1}{2}$ pounds nitrate potash, $1\frac{1}{2}$ pounds powdered alum, and 2 drams to 1 ounce arseniate of potash. This, in the form of a solution, is injected into the heart. This process embraces some peculiarities in the mode of treatment of the subject and manner of injecting the fluid.

Coffman's (1867). Distilled water, 1 gallon; carbolic acid, 4 ounces; nitrate of potash, 4 ounces; alcohol, 4 ounces.

Brunetti, of Italy (1867), expels the blood from the tissues by injections of pure water and of alcohol, and fatty matters by injections of sulphuric ether, and afterwards injects a solution of tannin into the arteries, veins, or excretory canals, after which the body is dried in a case heated by steam to a temperature of 90° centigrade.

E de la Granja (1867) employs a solution of sulphurous acid and the sulphides of soda, potash, or lime, in water or alcohol, injected into the aorta. The cavities of the body, head, thorax, and abdomen are filled with tannin, gun-cotton, camphor, and resin dissolved in absolute alcohol or ether, and stiffened with cotton and wax.

Em-bank'ment. A structure raised to prevent water from overflowing a level tract of country, or to support a roadway. Technically, in civil engineering, the earth removed to produce a level is excavation, and that which requires to be heaped up for the same purpose is embankment.

A raised mound or bank of earth to form a barrier against the encroachments of the sea. See DIKE.

Or against the overflow of a river. See LEVEE.

Or to carry a railroad, canal, or road across a tract of low ground or across a ravine or gully. See FILLING.

The oldest embankment in England is Roman, that of Romney Marsh. In the time of Cromwell, 425,000 acres of fen and morasses were recovered, 1649 – 51.

The embankment by which the Nile was turned from its course before the time of Abraham is mentioned under DIKE (which see). Reference is also there made to some of the works of Holland.

The bottom part of the embankment of the Amsterdam and Haarlem Railways through the low country consists of treble ranges of fascines, tied down by longitudinal poles 39 inches apart from center to center and 10 inches diameter, two double stakes at each end of the poles, and two ties in the intermediate distances. The interstices of the fascines and the space between the rows are filled in with sand. The upper part, forming the encasement for the ballast, is made of three rows of treble fascines, well staked, and wattled together.

A core of sand or clay, faced with step fascines, is made up to low-water mark. Upon this a bed of rushes, fastened down by stakes and wattles, is laid; and the upper portion of the bank is faced with fascines of a regular slope of 1 to 1. See also Wiggins's "Embankments of Lands from the Sea" (Weale's series).

Em-bat'tled. (*Fortification.*) Having a parapet with embrasures.

Em-bo'lus. Something inserted in another and moving therein, as a wedge, a piston of a steam-cylinder, the bucket or plunger of a pump.

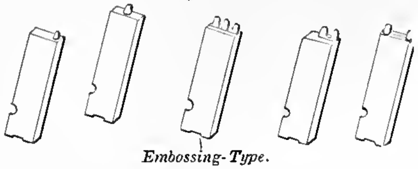
Em-bossed' Pa'per. Paper having an ornamented surface of raised work; done by stamping or rolling.

Embossed paper or cards may be copied in metal by taking a mold in wax, treating the surface with graphite, and subjecting it to electro-deposition in a bath of solution of sulphate of copper.

Em-bossed' Print'ing. Printing in which the paper is forced into dies, into which the letters have been cut or punched. The result is raised letters, used for printing for the blind, and various kinds of ornamental work.

Embossed typography is also effected by pressing

Fig. 1867.



Embossing-Type.

the type into the paper, raising the letters or characters on the other side. See PRINTING FOR THE BLIND.

Em-boss'ing. Ornamenting by raised work or figures in relief.

It is applied to many objects.

Stamps or initials are embossed on envelopes, paper, cards, etc.

Ornaments are embossed on book-covers, especially on those of cloth.

Leather is embossed for binding and many ornamental uses, saddles, porte-monnaies, pocket-books, satchels, etc.

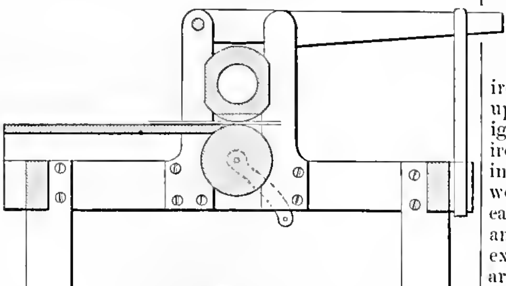
Textile fabrics are embossed for various purposes.

Glass is embossed — so called — by molding with raised figures.

Em-boss'ing-i'ron. (*Sculpture.*) A tool for giving a peculiar grained or caruncular appearance to a marble surface.

Em-boss'ing-ma-chine'. A machine in which a compressible material is placed between a rolling or reciprocating surface and a bed, the moving portion having a design in intaglio, which confers a cameo ornamentation upon the object. In Fig. 1868 the roller has a roughened surface and is rotated by a hand-crank. Above the roller is a hollow press-block having a removable convex-faced plate, with ridges for embossing any substance passed between it and the roller. The block is depressed by a pivoted lever having an elastic press-band over the end.

Fig. 1868.



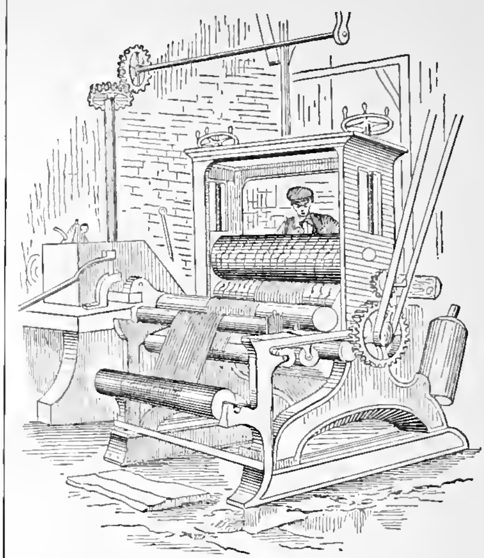
Embossing-Machine.

The hollow within the block serves to introduce some substance to heat the embossing-plate.

The embossing-machine for giving an indented ornamentation to velvet and other goods (Fig. 1869) has engraved copper rollers, which are heated by inclosed red-hot irons when operating on dampened goods, as in giving a "watered" surface.

Em-boss'ing-press. A hand-stamp or machine for giving a raised surface to an object placed between the descending die and the bed. In the example, the lever is raised by a spring, and is driven down by a blow of the hand, impressing the paper

Fig. 1869.

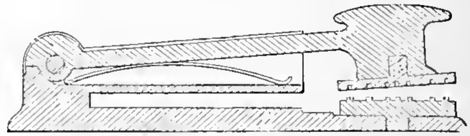


Embossing-Machine.

placed between the intaglio upper die and the cameo counter die.

Embossing-presses of bookbinders are screw, toggle, or lever presses, according to the area of sur-

Fig. 1870.



Embossing-Press.

face and character of material under treatment, and other considerations.

Em-boss'ing Wood. A process of indenting designs in wood by heat and pressure.

The wood is saturated with water, and the cast-iron mold heated to redness and pressed forcibly upon the wood. The water preserves the wood from ignition, though the surface is slightly charred. The iron is reheated, the wood re-wetted, and the branding-iron again applied. This is repeated until the wood fills the mold. The surface is cleansed between each operation, and finally with a scratch-brush, and any desired color may be retained or obtained by the extent to which the charcoal and discolored surface are removed.

Perforated designs are obtained by pressure upon portions of the surface and the removal of a scale of material by a saw. See CARVING.

Em-bra'sure. 1. (*Fortification.*) A crenelle opening cut through a parapet or wall to fire guns through.

The *cheeks* are the sides.

The *mouth* is the widest or outer part.

The *neck* is the narrow part.

The *sole* is the bottom part.

The *sill* is the front of the *sole*.

The *merlon* is the part of the parapet between two *embrasures*.

Embrasures are usually perpendicular to the parapet, but are sometimes inclined thereto so as to obtain a line of fire in a particular direction.

2. The inward enlargement of the cheeks or jambs of a window or door.

Em-broid′er-ing-ma-chine′. A form of sewing-machine in which the cloth is moved beneath the reciprocating needle-bar according to the requirements of the tracing, while the needles and hooks retain their respective relative positions above and below the fabric.

Heilmann's embroidery-machine (Mülhausen) has an arrangement by which the needles — 100, more or less — are attached to a carriage which travels to and fro in front of a vertical web. The needles have an eye in the middle and a point at each end. They are grasped by pincers and pulled through.

Em-broid′er-y. Ornamentation by raised figures of needle-work.

This is a very ancient art.

The Egyptians, Babylonians, Medes, and Persians all excelled in it.

The adornments of the tabernacle in the wilderness were of tapestry worked in blue, scarlet, and gold. The garment of Sisera, as referred to by Deborah, was embroidery, "needle-work on both sides." See DAMASK.

Homer refers to embroidery as the occupation of Helen and Andromache.

The tents of wealthy Arabs have an inner covering of white embroidered stuff beneath the dark, outer, water-proof covering of goat's-hair.

"The Tartar women excel in embroidery, and exhibit in this a skill, taste, and variety that is really admirable. It is very doubtful whether it would be possible to find, even in France, embroideries as beautiful and perfect as those sometimes executed by Tartar women." — ABBÉ HUC'S *Travels in Tartary.*

The tent of a late Persian shah was a load for forty camels, and cost $10,000,000. It was embroidered with gold, studded with precious stones and pearls; the figures representing animals, vegetables, and the works of men.

The Chinese, at the present day, are skillful and patient workers at this art, and excel in the disposition of colors.

The North American Indians have a certain rich and barbaric taste in the disposition of colors (preferably scarlet); with the addition of beads, porcupine quills stained, and other mere bizarre ornaments, such as skins, claws, and feathers of birds, claws of bears, ears of the lynx and fox, tails of *Mustelidæ*, shells, etc.

Embroidery is generally done in frames, the woven fabric being stretched flat and the needle passed through and through.

Em′e-rald. A type, used in England, between nonpareil and minion.

Nonpareil.
Emerald.
Minion.

Em′e-ril. A glazier's diamond. A *quarrel*, or *quarry*.

Em′e-ry. An amorphous, compact, opaque variety of corundum, consisting chiefly of indurated alumina. It is extremely hard and cuts almost all minerals, and is extensively used in cutting and polishing glass and other hard substances.

The emery is stamped to powder and sorted into finenesses by bolting through sieves of different degrees of fineness. For delicate purposes, it is sorted by elutriation. It is made up into various forms with gums, resin, glue, clay, etc., according to purpose.

Emery-cakes are used to dress the edges of buffs and glaze-wheels. They are formed of emery melted with bees-wax and made into cakes.

Emery-cloth is prepared by brushing the surface of thin cotton cloth with liquid glue, and sifting the emery-powder over the surface while still warm.

Emery-paper is made in the same way as emery-cloth.

Emery-sticks and rifles are pieces of wood prepared in the same manner.

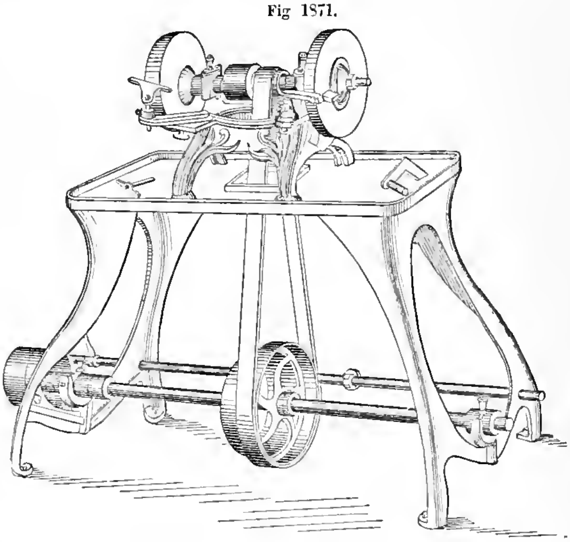
Emery-stones are made or formed of emery of the requisite coarseness, mixed with about half its weight of clay and water, to make a stiff paste, which is forced into a metallic mold by powerful pressure. They are then dried in a muffle. Disks, laps, and wheels are thus made.

Other cementing materials are frequently used instead of loam. See GRINDING MATERIALS; also list under GRINDING AND POLISHING.

Em′e-ry-grind′er. An emery-wheel mounted in a stand, to be used as a grindstone. It may be considered as such, indeed, the mineral corundum with a matrix of gum, resin, glue, vulcanite, etc.

The example is a double machine having two grinding-wheels and rests; one wheel being at one end and one at the other end of the mandrel, and both outside of the supporting frame. The faces or edges of the wheels may be used.

Fig 1871.



Emery-Grinder.

Em′e-ry-pa′per. Paper brushed with liquid glue and dusted with emery of the required grade of fineness.

Em′e-ry Vul′can-ite-wheel. A compound of emery and caoutchouc, molded into the shape of a grindstone or lap, and vulcanized.

Em′e-ry-wheel. This is a leaden wheel in which emery is imbedded by pressure, or more commonly a wooden wheel covered with leather and with a surface of emery. The wheel is fastened to a mandrel and rotated by a wheel and band; its principal use is in grinding and polishing metallic articles, especially cutlery. Those wheels in which the edges are used are grinders, buff-wheels, cloth-wheels, glazers, etc. When the flat surface of the disk is used, they are known as *laps*. The wheels may have coarse or fine cutting surfaces for different descriptions of work. For polishing, flour of emery, crocus, or rouge may be substituted. In machine-shops the emery-wheel is known as a *buff-wheel;* among cutlers it is a *glazer*.

Sometimes called a "corundum" wheel, from the specific name of the crystalline alumina used thereon. The hardest known substance next to the diamond. Emery is a dark, granular variety; the sapphire and ruby are peculiarly colored varieties.

E-met'ic-cup. A cup of metallic antimony in which wine is left for ten or twelve hours to become emetic.

Em-is-sa'ri-um. A sluice or flood-gate.

E-mol'li-o-type. (*Photography.*) A collodio-chloride picture on opal glass.

Em-plec'tum. A kind of masonry having a squared stone face; in the Greek it is represented as solid throughout, and in the Roman having a filling of rubble.

One form of Roman *emplectum* has courses of tiles at intervals. See MASONRY.

Em'press-cloth. (*Fabric.*) A lady's dress-goods, all wool and not twilled. It may be considered as an equivalent to the merino, excepting the twill of the latter.

En-am'el. A vitreous, opaque, colored material, tractable in the fire, and used in ornamenting metals; in painting on metals, to be subsequently fired.

Enameled bricks of various colors, blue, red, yellow, white, and black, are abundant in some of the mounds of Babylon and other cities in Mesopotamia. — LAYARD.

Enameled pottery has also been recovered at Thebes. Vestiges of the Roman occupation of Britain are occasionally disinterred in various parts of the country.

The art of painting in enamel or with metalline colors, and fixing them by fire, was practiced by the Egyptians and Etruscans on pottery, and passed from them to the Greeks and Romans. Enameling was also practiced among the Chinese. Specimens of enameled work are yet extant of early British, Saxon, and Norman manufacture. An enameled jewel, made by order of Alfred the Great, A. D. 887, was discovered in Somersetshire, England, and is preserved at Oxford. An enameled gold cup was presented by King John to the corporation of Lynn, Norfolk, and is yet preserved.

Luca della Robbia, born about 1410, applied tin enamel to pottery, and excelled in the art.

Bernard Palissy, the Huguenot potter, born about 1500, devoted many years to the discovery and application of enamels of various colors to pottery. He was remarkably successful in true copies of natural objects. His method died with him. He died in 1589, in prison, for conscience' sake.

John Petitot, of Geneva (1607 – 91), is regarded as one of the first to excel in portraits. He worked for Charles I. of England, and subsequently for Louis XIV. of France. The revocation of the Edict of Nantes drove him from France to the city of his birth, Geneva.

In 1632, Jean Tontin, of Chateaudun, introduced the practice of grinding the colors in oil of spike, instead of water.

Faïence and *majolica* may be considered forms of the art.

The enameled portrait of herself, presented by Queen Victoria to Mr. Peabody, is fresh in the recollection of those who speak the language common to the donor and presentee.

Enamel is applied to various kinds of pots and pans for stewing and preserving fruits whose flavor would be injured by contact with iron, and wholesomeness by being cooked in brass or copper.

The ordinary enamel for the purpose is common glass fused with oxide of lead. This will not resist vinegar and some other acids, and a dangerous poison may be present unsuspected in the mess.

Articles exposed to the weather are sometimes enameled to preserve them from rusting. This has been done with plowshares, mold-boards, water-wheels.

The asphaltum varnish which is burned on to some articles of hardware and household furnishing is not an enamel, but a bituminous varnish. The term *enamel*, as applied to these, is therefore a misnomer.

One of the most familiar examples of enameling is a watch-face. The white ground of these is first fired, the figures being added afterwards.

The backs of gold watches and numerous articles of jewelry are enameled by first engraving them so as to make depressions to hold the pulverized enamel, which is burned in, and the whole polished down to a uniform surface.

Enameled work may be ground by the horizontal lapidary mill or lead-wheel, with emery; second, the same with rottenstone and water; third, polished by the leather lap or buff-wheel with putty powder.

Or the process may be completed in a lathe, using the same materials, and either chucking the object to be ground and polished, or placing it on a mandrel.

In hand polishing, the work is roughed down with slips of water-of-Ayr stone and water, followed by slips of wood dipped in powder of pumice-stone and crocus successively.

En-am'eled Board. Card-board treated with a surface of white lead and size laid on by a large, flat brush and smoothed by a round badger's-hair brush. A powder of talc (silicate of magnesia) is rubbed upon the dried surface of lead, and the face is then polished by the brush.

En-am'eled Leath'er. A glazed leather for boots, shoes, carriage upholstery, and other purposes.

It is prepared from hides, which are split to the required thickness, well tanned, curried, and passed through two operations; the first to render the leather impermeable to the varnish, and the latter to lay on the varnish.

The hides used are those of kip, calf, ox, or horse. They are rubbed on the grain or flesh side with three coatings of boiled linseed oil mixed with ochre or ground chalk, and dried after each coating. The surface is then pumiced, treated with the same material of a thinner quality in several applications.

Over the surface thus prepared are laid successive layers of boiled linseed oil and of the oil mixed with lamp-black and turpentine spread on with a brush. The surface, which has become black and shining, is then varnished with copal and linseed oil with coloring matters. The following is recommended.

Boiled linseed oil	20 pounds.
Turpentine	20 "
Thick copal varnish . . .	10 "
Asphaltum, or	} 1 pound.
Prussian blue, or	
Ivory black	

Five coats of varnish are successively applied, and the colors are varied at will.

En-am'eled Pho'to-graph. (*Photography.*) Metal or pottery is used for the ground; the image is developed by nitrate of silver until the half-tints are overdone or obscured, and the deep shades are covered with a thick deposit. The heat of the muffle drives off the organic matters which formed but vehicles, and the fire cleans the image and restores the brilliancy and delicacy. A thin layer of flux fixes the image. See *Comptes Rendus*, June 11, 1855. "Photographic News," Vol. XIV. p. 86.

En-am'eled Ware. The enameling of hollow-ware is by a mixture of powdered glass, borax, and carbonate of soda, mixed, fused, cooled, and ground. The ware is cleansed with acid, wetted with gum-water, the powder dusted on, and then fused by heat carefully applied.

En-am'el-ing. The art of applying vitrifiable colors to metal, pottery, or glass.

The colors are prepared from the oxides of different metals, melted with a vitreous flux and laid on with a fine brush; the medium being oil of spike or some other essential oil. The work is heated in a muffle, which fuses the colors so that they adhere to the metal or other object.

The principal colors are oxides of lead, platinum, chromium, uranium. Oxides of tin and antimony give opacity.

The enameller works, not with actual colors, but with materials which will assume certain colors under the action of fire. See ENAMEL.

En-am'el-ing-fur'nace. For vitrifying the enamel coating on a plate, glass, or biscuit.

The work is placed in a *muffle*, which consists of an arched chamber in the midst of a small furnace, and surrounded by fuel, which keeps it at a red heat, although the fuel cannot touch the work.

The furnace and muffle are sometimes made of sheet-iron mounted on legs so as to bring the work to the level of the artist's eye.

En-am'el-ing-lamp. (*Glass.*) A glass-blower's lamp with blow-pipe for performing some of the more delicate surface ornamentation of glass.

En-am'el-kiln. (*Porcelain.*) The enamel-kiln for firing porcelain which has been *bat-printed*, that is, *printed on the glaze*, is made of fired-clay slabs, and is 6½ by 3½ feet, and 7½ feet high, with flues beneath and around. The fireplaces are at the sides, and smoke and flame are excluded from the interior.

En-am'el-paint'ing. Vitrifiable colors are laid on metal and fused to it. See ENAMEL.

En-am'el-pa'per. Paper with a glazed metallic coating.

Various metallic pigments are employed, such as will spread smoothly and take a polish. The pigments are white lead, oxide of zinc, sulphate of barytes, china, clay, whiting, chalk, in a menstruum or upon a previous coating of glycerine, size, collodion, water, varnish, etc.; afterwards polished by an agate or between calendering or burnishing cylinders.

En-caus'tic. A mode of painting in which the colors are laid on or fixed by heat.

The ancient Greek encaustics were executed in wax-colors, which were burned in by a hot iron, and covered with a wax or encaustic varnish. Pictures in this style were common in Greece and Rome. (See Smith's "Dictionary of Greek and Roman Antiquities.") The credit to Gausias, of Sicyon, 33 B. C., as the inventor, is rather to be taken as an indication that he was an improver.

Sir Joshua Reynolds, in his attempts to fix his colors durably, mixed wax with them as a vehicle. On one occasion he placed his painting before a fire to mellow the tints by warming the wax. On returning, he found the lady's face had slipped down over her bosom.

The term "encaustic" at the present day is mostly confined to colors burnt in on vitreous or ceramic ware.

By the ancient method, according to Pliny, the colors were made up into crayons with wax, and, the subject being traced on the ground with a metallic point, the colors were melted on the picture as they were used. A coating of melted wax was then evenly spread over all, and, when it was quite cold, was polished.

The art was revived by Count Caylus in 1753. The wood or canvas is coated with wax, which is warmed at the fire. The colors are mixed with white wax and powdered mastic, which are rubbed smooth with gum-water and applied with a brush. The surface is coated with white wax and polished.

En-caus'tic-brick. Diodorus Siculus relates that the bricks of the walls of Babylon, erected under the orders of Semiramis, "had all sorts of living creatures portrayed in various colors upon the bricks before they were burnt."

En-caus'tic-tile. An ornamental tile having several colors. A mold is prepared which has a raised device on its face so as to leave an impression in the face of the tile cast therein. This intaglio recess is then filled by a trowel with clay compounds, in the liquid or *slip* state, and which retain or acquire the required colors in baking. The tile is then scraped, smoothed, baked, and glazed. This tile is common in ancient and modern structures. The glazing came from the Arabs, who derived it from India, and primarily from China.

En-ceinte'. (*Fortification.*) The line of circumvallation; the space inclosed within the ramparts of a fortification.

En-chased'-work. Chased work in silver and gold smithing. See CHASING.

En-chas'ing. A form of engraving which results in an ornamental embossing. It is partly executed by punching on the back and partly by the graver.

Another mode is by filling the object with pitch or lead, and then indenting from the outside.

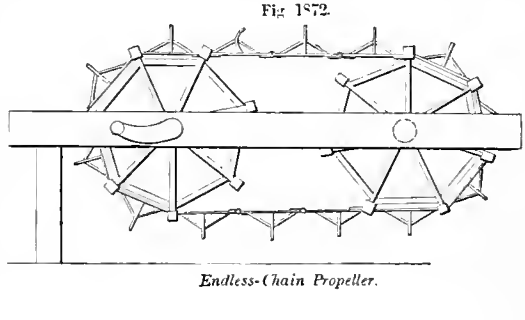
The modes are variously combined, according to the object, the style, and the material. See CHASING.

End. 1. A sliver or carding.

2. (*Weaving.*) One of the worsted yarns in a loom for weaving Brussels carpet. It proceeds from a bobbin on the frame and through a small brass eye called a *mail*, by which it is lifted when its turn comes to be raised to form a loop in the pattern. See BRUSSELS CARPET.

End'less-chain Pro-pel'ler. One in which the paddles are attached to a traversing belt or sets of chains, which rolls over two parallel wheels.

Fig. 1872.



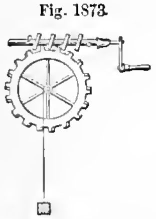
Endless-Chain Propeller.

End'less-saw. A *band-saw*, consisting of a steel ribbon serrated on one edge and passing continuously over wheels above and below the work-table. Used for scroll-sawing, etc. See BAND-SAW.

End'less-screw. A screw whose action is continuous, engaging the teeth of a wheel which is revolved thereby. It is used in graduating-machines, registers, odometers, and in many other places where a means of slow and positive rotation to a wheel is required. A *worm-wheel.*

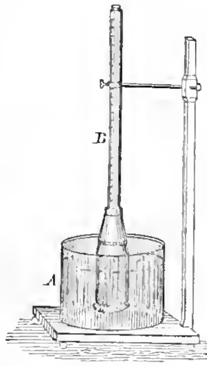
There is a necessary relation between the pitch of the worms on the shaft and of the teeth on the wheel, and a revolution of the shaft moves the wheel a distance of one tooth. By an index arrangement on the shaft to enable it to be turned a certain portion of a revolution, say through 6°, and having, say, sixty teeth in the wheel, the latter may be turned $\frac{1}{3600}$ of a revolution at a time, a distance inappreciable to the eye. This is the *micrometer-screw.* See MICROMETER.

Fig. 1873.



Endless-Screw.

Fig. 1874.



Endosmometer.

En-dos-mom'e-ter. An instrument invented by M. Dutrochet to measure the rapidity of endosmotic action; that is, the passage of a less dense fluid through a membrane which separates it from a denser fluid. The *exosmose*, or passage of the denser fluid in the opposite direction, is slower.

A simple form of the instrument is a trumpet-shaped tube with a membrane covering its bell mouth. The tube is filled with a solution of a given density and plunged in a solution of lesser or greater density to ascertain by successive trials the relative rapidity of the endosmotic or exosmotic actions, or the action of different fluids.

End-shake. A certain freedom of endwise motion of a spindle or arbor, which has bearings at each end, so that the shoulders of the gudgeons or pivots (as in a watch) shall not bear against the journal-boxes or plates.

End-stone. One of the plates of a watch-jewel against which the pivot abuts. See JEWEL.

En'e-ma-chair. One specially constructed for the administration of clysters to the helpless and infirm.

En'e-ma-syr'inge. A syringe for injection *per ano.* See INJECTION-SYRINGE.

En-er'gi-o-type. (*Photography.*) Mr. Hunt's process, called so by him from a supposed influence which he called *energia*, as distinct from light (visible).

En'field Ri'fle. The British infantry service-arm prior to the introduction of the breech-loading system. It was first extensively introduced in 1853, just prior to the Crimean War. It has three shallow grooves, which make one turn in 6 feet 6 inches, the length of the barrel being 3 feet 3 inches, and the diameter of the bore .577 of an inch. In construction and general appearance it very closely resembles the Springfield rifle musket (caliber .58 of an inch) of the United States service, with the exception that in the Enfield the barrel and other visible metallic parts are blued, while in the latter they are left bright. Large numbers of these rifles have of late years been converted into breech-loaders on the Snider principle. To these the term "Snider Enfield" is applied. See FIRE-ARM.

En'fil-ade. (*Fortification.*) The act of obtaining a fire on a work in the direction of one of its faces.

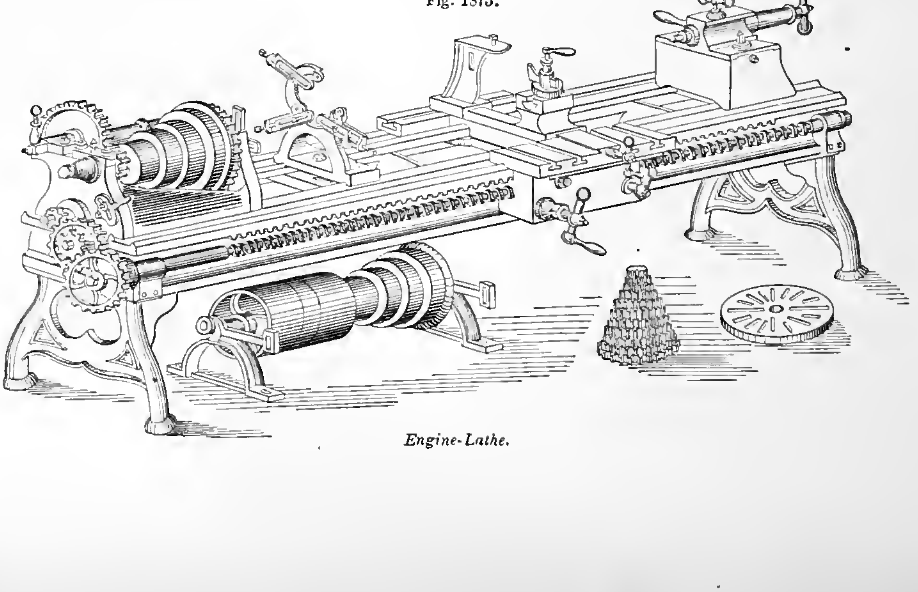
En'gine. A machine which acts automatically, both as to power and operation.

Distinct from a *machine* in its ordinary acceptation, whose motor is distinct from the operator, and a *tool*, which is propelled and operated by one person.

En'gine-fur'nace. A furnace appertaining to a steam-engine boiler.

En'gine-lathe. A lathe of the larger kind, having a capacity for all the principal turning work of a machine-shop. That shown in Fig. 1875 has screw gearing, center and follow rests, and face-plates. On the floor are shown the overhead counter-shaft and cone-pulley, a pile of change-wheels, and a face-plate.

Fig. 1875.



Engine-Lathe.

En'gine-sized. Paper sized by a machine, and not while in the pulp, in a tub.

En'gine-turn'ing. A system of ornamented turning done in a rose-engine lathe, and commonly seen on the outside of watch-cases.

En'gi-scope. A reflecting microscope, invented by Amici, in which the image is viewed at a side aperture in the tube, in a manner similar to the Newtonian telescope.

Eng'lish. (*Printing.*) A size of type between *Great Primer* and *Pica.*

Great Primer, 51 ems to a foot.

English, 64 ems to a foot.

Pica, 71 ems to a foot.

En-grav'ing. Engraving is very ancient. The oldest records are cut in stone, some in relief, some in intaglio. The hieroglyphics of Egypt are cut in the granite monoliths, and on the walls of the tombs and chambers.

In Exodus xxviii. we read that two onyx stones were to be engraved like a signet with the names of the tribes, 1491 B. C. The two kinds of stones of the high-priest's breastplate were engraved with the names of the tribes of Israel. Seals and signet-rings with the cartouches of the Pharaohs are in many museums; those of London, Berlin, Paris, and the New York Historical Society, for instance.

The "graving with an iron pen and lead," referred to by Job (chap. xix.), consisted probably of an etching or scratching process, that of a sharp stylus upon a piece of sheet-lead; Hesiod's poems were thus preserved. The date is not quite determined at which this patriarch of Uz lived; but assuming him to be coëval with Moses, we find quite an advanced state of the art in the time and country of the latter. Moses was learned in all the wisdom of the Egyptians, and when the Israelites went out of Egypt there were a number of skillful workmen able and willing to engrave on precious stones and on metals.

The tools, weapons, and ornaments of the ancient Egyptians are in some cases elaborately engraved. Chasing and carving, which are kindred arts, flourished in the kingdom watered by the Nile.

Layard and his friends disinterred from the mounds of Nimroud, and at other places, many specimens of the graver's art; copper vessels, beautifully engraved, were among the number.

Carving in stone is closely allied to the above, and may be be termed engraving in stone. Egypt is one triumphant vindication of the skill and industry of that nation in this particular. The warlike Osymandyas, nearly 200 years before Abraham, perpetuated upon granite the memory of his exploits, which reached as far as and included Bactria.

The temples, tombs, and obelisks of Egypt, the sculptured palaces of Nineveh, and the gorgeous rilievos of Persepolis, attest the skill and fancy of the artists of the times

"Ere Romulus and Remus."

From Egypt or Phœnicia the Greeks received the art of engraving, where it had considerably advanced in the time of Homer. Among other uses which are allied to chasing and inlaying, it was employed in delineating maps on metallic plates. Specimens of Etrurian art are also of great antiquity, and we prudently do not enter the arena to settle the questions of precedence so lately revived by the wonderful discoveries of General Di Cesnola, in Cyprus.

In the temple of Jupiter Capitolinus were stored 3,000 brass plates on which the laws of Rome were engraved. The ancient engraving was much of it complete enough for printing, but was generally intended for impressions in plastic material, clay, wax, and what not. (See SEAL.) It is, however, believed that parchment, linen, silk, and papyrus were sometimes impressed by the surface of the seal, previously blackened by ink or pigment.

Other than this, the first we know of engraving as a means of delivering an impression in ink or color was among the Chinese. See PRINTING.

The art of engraving is fairly referable to three divisions: *chalcography*, or plate-engraving; *xylography*, or wood-engraving; *lithography*, or stone-engraving: the names being derived from the Greek words *chalcos*, *xylon*, *lithos*, respectively, and the terminal *graphein*, I write.

Engraving on metal originated with chasers and inlayers. This art is very ancient, but does not seem to have suggested the sister art of printing from the plates thus engraved. It appears singular that it did not, for a common mode of examining a piece of engraved work is to fill the engraved lines with a dark liquid, — the dirty oil, for instance, of the polishing rag, — so as to make visible the lines and the effect produced. A piece of soft paper laid on this would obtain an impression, imperfect, it is true, but apparently sufficient to have suggested the art of copperplate printing. In taking a cast in sulphur of some engraved church ornaments, it is stated that a Florentine artist named Finiguerra, about 1440, was led at length to the discovery of the value of plate-engraving as a means of printing. Some dust and charcoal which had gathered in the lines came out upon the sulphur and gave an unexpected and suggestive effect.

Vasari records a similar mode of taking impressions in work, and states that "from these engravings the artists were in the habit of taking impressions by smoking them, and then, after cleaning the surface with oil, impressing upon the work a damp paper." The collections of impressions of these plates in the Florentine and other museums show that, previous to the time of Finiguerra, they are but proofs of inlayer's work, and that they were not made with a view to furnishing prints; the figures have their swords, pens, etc., in their left hands in the impressions, instead of the right.

Had they been engraved for the purpose of printing, the figures would have been reversed on the plate, so as to print right.

Euclid was printed with diagrams on copper in 1482. The copperplate roller-press was invented in 1545. Etching on copper by means of aqua-fortis invented by F. Mazzuoli or Parmegiano, A. D. 1532. Mezzotinto engraving invented by De Siegen, 1643; improved by Prince Rupert, 1648; and by Sir Christopher Wren, 1662.

"Mr. Evelyn showed me most excellent painting in little [miniature]; in distemper, in Indian incke, water-colours: graveing; and, above all, the whole secret of mezzo-tinto, and the manner of it, which is very pretty, and good things done with it." — PEPYS'S *Diary*, Nov. 1, 1665.

At Gresham College, the Royal Society meeting, Mr. Hooke explained to Mr. Pepys "the art of drawing pictures by Prince Rupert's rule and machine and another of Dr. Wren's [Sir Christopher]; but he [Dr. Hooke] says nothing do like squares, or, which is best in the world, like a dark room." — PEPYS, Feb. 21, 1666.

These devices are apparently for copying; the former is probably on the principle of the pantograph; the squares is a familiar mode of reducing or enlarging by ruling off into equal numbers of squares the original and the paper on which it is copied. The *dark room* is probably the *camera-obscura*, in the simple form of a hole in a shutter of a darkened apartment.

"Cocker [the famous arithmetician] says, that the best light for his life to see a very small thing by, contrary to Chaucer's words to the Sun, that he

'Should lend his light to them that small seals grave,'

it should be by an artificial light of a candle, set to advantage as he could do it." — PEPYS'S *Diary*, Aug. 8, 1664.

"Come Mr. Cocker, and brought me a globe of glasse, and a frame of oyled paper, as I desired, to show me the manner of his gaining light to grave by, and to lessen the glaringness of it at pleasure, by an oyled paper. This I bought of him, giveing him a crowne for it; and so, well satisfied, he went away." — *Ibid.*, Oct. 5, 1664.

Aquatint engraving invented by St. Non of France, 1662. Engraving in steel introduced into England by Perkins of Philadelphia, 1819.

The earliest application of the wood-engraver's art in Europe was in cutting blocks for playing-cards. The French writers ascribe it to the time of Charles V., but the Germans show cards of the date 1300. The Italians again claim that it originated in Ravenna, about 1285. An Italian pamphlet of the year 1299 speaks of cards as a gambling game, but these may have been drawn by the pen and colored by hand. In the year 1441 the Venetian government forbade the importation of *stamped* playing-cards as being injurious to their handicraft manufacture. Ugo di Carpi introduced the method of printing in colors or tints by separate successive blocks. Engraving on wood assumed the character of an art about 1440; the first impression, 1423. Improved by Durer, 1471–1528; by Bewick, 1789.

Engraving on stone. Work done upon a lithographic stone by etching-point, diamond, or ruling-machine: the stylus of the latter is a diamond.

There are two modes, the first of which is the more usual: 1. The stone is covered with a gum and acid ink-resisting compound, dried, and the design scratched through this ground to such a depth merely as to expose the clean stone. The stone is then oiled, the engraved portions alone absorbing the oil: it is afterwards washed, rolled up, and printed. Printing is, however, usually done from transfers from the engraved stones.

2. The stone is etched through a ground of asphaltum; acid is applied to deepen the lines. These are inked; the face cleaned off, gummed, and etched, the stone rolled up and printed.

Engraving is in many styles, and these are briefly considered under their respective heads, as follows: —

Anaglyphtograph.
Anastatic engraving.
Aquatint.
Autopyrograph.
Banking.
Bite-in.
Bridge.
Burin.
Burnisher.
Cameo.
Celature.
Chalcography.
Chalk-engraving.
Chasing.
Chemitype.
Clamming-machine.
Copperplate engraving.
Counter-proof.
Cradle.
Cycloidal-engine.
Dabber.
Daguerreotype etching.
Diamond-point.
Die.
Dotting.
Draw-point.
Drive.
Dry-point.
Eccentric-engine.
Ectypography.
Electro-engraving.
Electro-etching.
Electro-tint.
Engraving.
Engraving-machine.
Engraving. Photo-
Etching.
Etching-ground.
Etching on glass.
Etching-point.
Finishing.
Galvanograph.
Gem-engraving.
Glass-engraving.
Graver.
Ground.
Grounding-tool.
Intaglio.
Line-engraving.
Lithography.
Lithotint.
Lozenge-graver.
Medallic-engraving.
Mezzotint-engraving.
Niello.
Passe-partout.
Photographic-engraving.
Photograph-plate engraving.
Proof.
Rebiting.
Re-entering.
Relief-line engraving.
Reversing.
Rocker.
Rocking.
Roulette.
Round-point.
Rubber.
Ruling-machine.
Scraper.
Seal-engraving.
Small chisel.
Steel-plate engraving.
Stipple.
Stopping.
Tint-tool.
Transferring.
Transferring-machine.
Wood-engraving.
Xylography.
Zincography.

En-grav'ing-ma-chine'. 1. A machine in which an intaglio impression is delivered upon a plate or cylinder for bank-note printing, or calico-printing, by the rotation under contact with the said object of a hardened steel roller (*mill*) bearing the design in cameo.

This system was invented by Jacob Perkins, and was first adopted in bank-note engraving. (See TRANSFERRING-MACHINE.) The process for obtaining in the design in cameo on the *mill*, by rotation in contact with an intaglio *die*, is effected in a transfer press. See also CLAMMING-MACHINE.

A pantograph is used in etching a reduced copy of a pattern on to the copper cylinder for calico-printing.

Eccentric-engraving, for a certain class of patterns in calico-printing, is performed by a diamond etching-point on the varnished roller. The points are moved by elaborate machinery, and the effect is analogous to that of the *eccentric* and *rose-engine* lathes.

2. An apparatus on the principle of the pantograph, but provided with a cutting device and machinery for causing pressure upon the surface to be engraved, so as to produce lines similar to those made by hand with the graver.

Collas (English patent) engraving-machine, 1830. Electro-magnetic engraving-machine used in Germany, 1854; in America, 1858.

Guerrant and Field's engraving-machine was patented in 1867, and was in operation in New York City during the year 1868. To engrave by means of this machine the operator sits with a copy of the drawing, photograph, or whatever design is to be engraved, directly in front of him. A small pointer rests upon the drawing, and the whole operation consists in moving the pointer over the several lines of the copy. The pointer is operated by two small cranks, one of which produces a vertical and the other a lateral movement; the simultaneous operation of both cranks producing a circular, inclined, or any desired irregular motion of the pointer, which is thus made to "follow copy." All the movements of the pointer are imparted, by means of a simple arrangement of levers, to a graver, which cuts or engraves the design upon the surface of a copper plate or block.

At the Paris Exposition of 1868, an apparatus was exhibited by M. Gaiffe, of Paris, for engraving by electro-magnetism. It consists of two or more disks having their faces in the same vertical and their axes in the same horizontal plane. The graving tools are provided with diamond points, and are connected with the armature of an electro-magnet, and with a tracing-point in contact with the pattern-plate. The tracing-point and graver are caused to approach the centers of their respective plates by a gradual and uniform motion, forming a spiral of extremely close involutions. A design is drawn on the pattern-plate in a non-conducting ink, and as the plates revolve together whenever the tracer crosses one of the lines of the pattern the circuit is broken, and the graver takes the metal of the plate to be engraved; when the tracer, on the contrary, is in immediate contact with the metal of the pattern, the graver is withdrawn from the plate to be engraved.

When the tracer has thus passed over all parts of the pattern-plate from the circumference to the center, a fac-simile of the pattern will have been engraved, in which, however, all the lines of the original will be represented by a series of dots. The pattern may be reduced or enlarged by the application of the pantographic principle; and by the use of a series of gravers arranged on a pivoted bar at various distances from its center of motion, several copies may be made at the same time on scales proportioned to the distance of the gravers from this center.

En-larg'ing-ham'mer. The gold-beater's hammer, by which he reduces the package of *quartiers* or gold-plate. Fifty-six of the *quartiers* form a package (*caucher*), and are interleaved with vellum. The hammer weighs fourteen or fifteen pounds, and is shaped like a truncated hexagonal pyramid, 6 inches high. Its face is very slightly convex, and 5 inches diameter.

En-le-vage'-style. A mode of CALICO-PRINTING (which see).

E-nor'tho-trope. A toy on the principle of the *thaumatrope*, the *stroboscope*, and *phenakistoscope*, which depend for their action upon the persistence of visual impressions. Upon different parts of a card are detached parts of a given figure, and when the card is rotated these become assembled and give a combined impression to the eye.

En-rock'ment. Stone pitched on to the sea-face of a breakwater or dike, or a shore subject to encroachment by the waves or stream.

En-tab'la-ture. 1. (*Architecture.*) That portion of a classical structure which rests on the columns; it consists of an *architrave*, *frieze*, and *cornice*.

An attic or blocking-course is sometimes added.

Those members of a portico which were constructed upon the columns, consisted of the epistylium, zophorus, and corona.

2. (*Machinery.*) A strong iron frame supporting the paddle-shaft. It usually receives additional stiffness from being confined between two beams of timber, called the *entablature* or *engine-beams*.

En'ta-sis. The swell of the shaft or columns of either of the orders of architecture.

En'ter-ing-chis'el. A spoon-chisel; used by sculptors.

En'ter-ing-file. A narrow, flat file, with considerable taper, to enable it to enter and open a groove, which may be finished by a *cotter*-file, for instance.

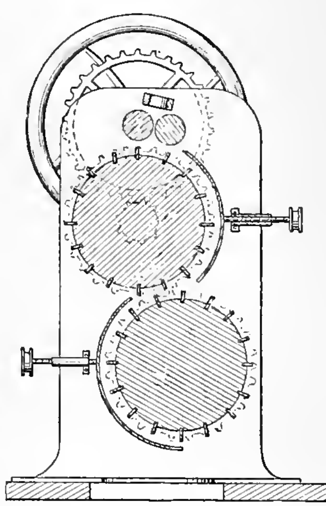
En'ter-ing-port. (*Shipbuilding.*) A port cut in the side of a vessel to serve as a door of entrance.

En-ter'o-tome. An instrument for opening the intestinal canal through its whole extent. It consists of a pair of scissors, one blade of which is made longer than the other, and rounded at its extremity. This is passed into the intestine.

En-to-mom'e-ter. An instrument for measuring the parts of insects.

En'trail-clean'ing Ma-chine'. A machine for cleaning guts for sausage holders or strings.

Fig. 1876.



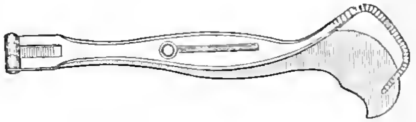
Entrail-Cleaner.

Two rollers, revolving in opposite directions and armed with scrapingedges, are surmounted by elastic feed rollers, and provided each with an adjustable curved surface for pressing the entrails against the scrapingedges.

En'tre-sol. (*Architecture.*) A low story or part of a story in a building, between two higher ones. *Intersol.*

En-tro'pi-um For'ceps. Forceps for grasping and returning to the natural position the eyelid, in which, by inversion, the eyelashes have become turned inwardly.

Fig 1877.



Dr. Prout's Entropium Forceps.

En've-lope. 1. A paper case to contain a folded letter.

2. (*Fortification.*) The exterior line of works surrounding a fort or fortified position.

The besieged are said to be enveloped when completely surrounded by the works of the besiegers.

En've-lope-ma-chine'. The manufacture of envelopes is said to have been introduced by an English stationer named Brewer, some fifty years ago. He cut them from the sheet with the aid of metallic formers, and folded and gummed them by hand with the brush, in the manner generally practiced until a comparatively recent period.

An envelope-machine was invented as far back as 1840, but De la Rue's, 1845, appears to have been the first which achieved any notoriety.

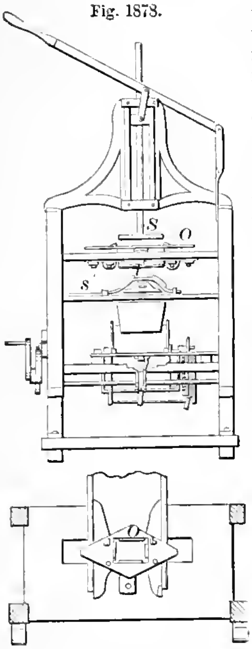
Envelope-machines, so called, generally comprise only provisions for folding and gumming the envelope after it has been cut to the proper form.

The English envelope-machine, invented by Hill and De la Rue, operates upon diamond-shaped pieces of paper, which are successively placed on the platform. A plunger descends and forces the central part of the paper into an oblong quadrangular cavity; the four corners stand erect and are successively flattened by four fingers. When the folding is completed, two india-rubber fingers lightly touch the envelope and draw it aside to make room for another. These fingers are small metallic cylinders with tips of india-rubber, which adhere sufficiently to the paper to retract it from its place in the machine and make room for another. The gum is spread over an endless apron or blanket, and an artificial arm takes a supply and applies it to the envelope in its proper place, just before the flap is folded down. As fast as the envelopes are made they are automatically ranged on an inclined plane and slide into a box. The machine (1853) made sixty a minute.

M. Rémond's envelope-machine feeds the blanks by means of a pneumatic apparatus known as an aspirator, consisting of a hollow tube which is thrust forward and rests on the upper blank; the air is exhausted from the tube by an air-pump, and the blank becomes attached thereto by atmospheric pressure. The tube is then withdrawn, removing the blank, which is dropped at the required place, by the relaxation of the atmospheric tension.

The machine of Robineau and Roumestant, exhibited at the Paris Exposition of 1867, also lifts the blanks singly by atmospheric pressure, and folds them and gums them by a series of operations similar to those of Rémond's machine.

Fig. 1878.



Keating's Envelope-Machine.

In another machine, the paper is fed in a continuous strip of a given width for a certain size envelope First are made transverse incisions, which answer for a portion of the division between the adjacent envelopes; the rectangular crease is made determining the size of the envelope, slits made from the corners of the latter to the edges of the paper; the included flaps are folded over and paste applied; the superfluous edge strip is cut off, and the angular division is made between the adjacent envelopes; the envelope is bent on the folding-line and passed between rollers, to be afterwards dried and have its flap gummed.

In Keating's machine, the paper blanks are placed on a reciprocating feeder-plate *O* and carried forward under the plunger *S* by small hooks or projections. The plunger descends, doubles the blanks by their contact with the creasing-rollers, and leaves the blank on a flat hinged bed, where the flap-folders are actuated to fold consecutively. The auxiliary presser *s'* operates upon the gummed portion, starting directly after the gum-flap folder, which is cut away to allow its passage, and rises a little in advance of it. The counting apparatus is a ratchet and pawl arrangement.

E-o'li-an. 1. A frame with catgut strings which are vibrated by the wind. See ÆOLIAN.

2. An *eölian-attachment* to a piano-forte is a supplementary arrangement of a bellows and set of reeds which are called into action at the discretion of the performer.

E-o'li-pile. The rotary steam-engine of Hero. See ÆOLIPILE.

E-paule'. (*Fortification.*) The shoulder of a bastion; the salient angle formed by the face and flank.

E-paule'ment. (*Fortification.*) A species of breastwork formed to defend the flank of a post or any other place.

A work thrown up to defend troops from an attacking force; usually shoulder-high, hence the name epaulement.

E-pergne'. An ornamental stand for a large dish on a table.

Ep'i-cy'clic Train. (*Gearing.*) An epicyclic train is one in which the axes of the wheels revolve around a common center. They are used for various purposes. Several are shown under the heads EQUATIONAL BOX; SUN AND PLANET MOTION; PARALLEL MOTION; EPICYCLOIDAL WHEEL, etc.

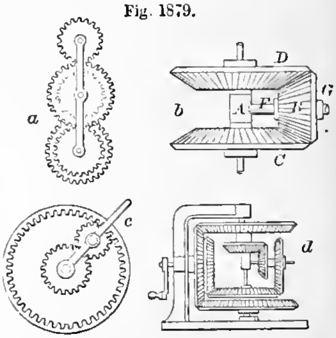
Their forms are numerous, curious, and ingenious. (See page 120, Brown's "Five Hundred and Seven Mechanical Movements.") Quite a number of applications of the device have been made to harvesting-machines, in transmitting the motion of the driving-wheel axle to the cutter-bar.

a b c d are forms of epicyclic gearing.

The epicyclic train *b* has some features in common with Houldsworth's equational-box for regulating the relative speeds of the spindle with its flyer, and the bobbin, in the roving-frame.

If motion be imparted at the same speed and in the same direction to the loose wheels *D C*, the effect is to revolve *B* around the shaft *A* without rotating *B* on its axis *F G*; they all move together as if pinned fast in a cluster.

Fig. 1879.



Epicyclic Trains.

If motion be imparted to the loose wheels *D C* at the same speed in opposite directions, the effect is to rotate the wheel *B* on its axis without revolving it on the common axis *A*.

Unequal rates of motion of the wheels *D C*, either in the same or opposite directions, will cause the wheel *B* to rotate on its axis, and with its axis *F G* to revolve around the common center *A*.

In Entwistle's patent gear, three bevel gears of even size are thus associated, and the device is used for steering-apparatus, multiplying speed for screw-propellers, etc.

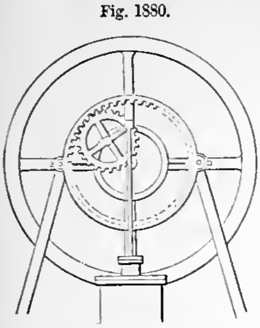
Driving from the other end of the train gives power with decrease of speed.

Many ingenious applications of the device might be cited and shown would space permit.

Ep'i-cy-cloid'al Wheel. An epicycloid is a curve generated by a point in the circumference of a movable circle, which rolls on the inside or outside of the circumference of a fixed circle. See SUN AND PLANET MOTION, the invention of Watt.

An epicycloidal wheel is a contrivance for securing parallel motion, in converting reciprocating motion into circular, depending on the principle that an inner epicycloidal curve becomes a straight line when the diameter of the fixed circle is just double that of the rolling one. It consists of a fixed ring, with teeth on the inside, into which is geared a wheel of half its diameter; to a pin on the circumference of the smaller wheel the reciprocating motion is communicated, while the center of the wheel describes a circle and may receive the pin of a crank whose shaft is concentric with the ring. — WEBSTER.

Fig. 1880.



Epicycloidal Wheel.

Ep′in-glette′. An iron needle for piercing a cannon-cartridge before priming.

E′prou-vette′. 1. An apparatus for proving the strength of gunpowder.

One simple mode is to fire weighed charges and ascertain the range of the balls. A small quantity of powder, a heavy ball, and a short mortar reduce the range within convenient limits.

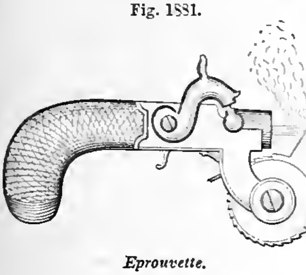
Another is to fire a small quantity beneath a shot attached at the foot of a vertical rod. The latter ascends, and, on reaching its greatest elevation, is prevented from descending by a pawl which engages a rack on the rod. The hight to which the shot ascends determines the strength of the powder.

The éprouvette of Regnier is an adaptation of the Sector dynamometer. A small brass cannon is attached to one arc and charged with a given quantity of powder. A projection from the other arc comes in front of the muzzle, and the parts are separated when the explosion takes place.

A cursor over the graduations indicates the point reached by the force of the explosion. See BALLISTIC PENDULUM.

A convenient and portable éprouvette is an instrument shaped like a small pistol without a barrel, and having the forward end of its charge-chamber closed by a flat plate connected with a spring. On the explosion of the powder against the plate, the latter is driven forward to a distance proportioned to the strength of the powder, and is retained at its extreme range of propulsion by a ratchet-wheel and spring-click.

Fig. 1881.



Eprouvette.

Pouillet's chronoscope and Navez's electro-ballistic apparatus, by measuring the velocity attained by balls with charges of certain powders, form good *éprouvettes*. See CHRONOSCOPE; ELECTRO-BALLISTA.

2. (*Metallurgy.*) A flux spoon. A spoon for sampling an assay.

E′prou-vette′-gun. The gun-éprouvette determines the strength of the powder by the amount of recoil produced. A small piece of ordnance is fastened to a frame which is suspended as a pendulum so as to vibrate in an arc when the piece is fired. A pointed iron rod projects downward from the gun, and travels in a groove of soft wax as the gun recoils, thus making a mark which is measured to determine the length of the arc. A graduated arc with an index-finger is used in the British service. The gun is of brass, 1¾ inch bore, 27.6 inches long, weighs 86½ pounds; suspended from a frame and charged with two ounces of powder without shot or wadding.

The éprouvette-mortar of the British service is 8 inches in diameter, and is charged with 2 ounces of the powder, and an iron ball of 68½ pounds weight; average range of 265 feet. The government powder, somewhat deteriorated and reserved for blasting, gives a range of 240 feet.

The French éprouvette-mortar has a caliber of 7 inches; charge, 3 ounces; projectile, a copper globe of 60 pounds; required range, 300 yards.

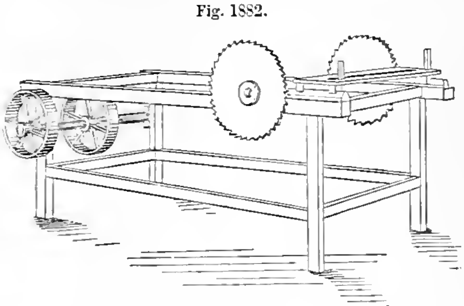
The éprouvette-mortar of the United States service is a 24-pounder, having a chamber to contain one ounce of powder, and no windage to the ball. The required range for new powder, 250 feet.

E′qual-ing-file. A flat file which has a constant thickness, but may taper a little as to width.

E′qual-iz-er. An *evener* or whiffletree to whose ends the *swingle-trees* or *single-trees* of the individual horses are attached. A three-horse equalizer divides the load to three draft-animals. See TREBLE-TREE.

E′qual-iz-ing-saw. A pair of saws on a mandrel at a gaged distance apart, and used for squaring off the ends of boards and bringing them to dimensions.

Fig. 1882.



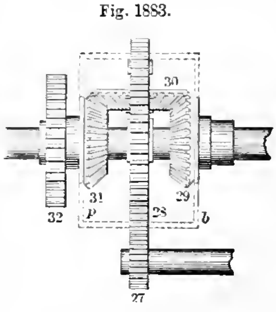
Equalizing-Saw.

E-qua′tion-al Box. Invented by Houldsworth. A differential gearing used in the bobbin and fly machine for the adjustment of different degrees of twist, for different yarns. The bobbin and flyer are driven independently, and the arrangement affords a means of changing the relative speeds.

Two short cylinders *b p* inclose bevel wheels 29 31. Between the edges of these boxes is a spur-wheel 28, driving a third bevel-wheel 30, mounted on an axis forming the radius of the spur-wheel, and occupying a slot in the *web* of the wheel.

The wheel 30 has the same diameter and number of teeth as the wheels 29 31, with which it engages. The wheel 29 is keyed to its shaft; but wheels 28 31 run loosely on the shaft and independently

Fig. 1883.



Equational Box.

of it. Now, if wheel 28 be held still and wheel 29 be turned, the middle wheel 30 will act merely as a carrier between 29 and 31, which will turn with the same speed, but in opposite directions. If 28 be turned at the same speed as 29 and in the same direction, the middle wheel 30 will not revolve on its axis, but acts *as a pin* between 29 and 31, causing them to turn with the same speed and in the same direction. These are the *extreme cases.* The middle case is when 28 turns with half the speed of 29, in which case 31 does not revolve at all. All possible variations between the relative speeds of 29 and 31 can therefore be attained by changes of velocity in 28. This is accomplished by putting a larger or smaller pinion on shaft *K*, which has a regular rate of motion relatively to shaft *B*.

Wheel 32 is joined to 31, and drives the *bobbins*, whose speed is adjusted in any required ratio to that of the spindles and flyers, whatever may be the speed of the latter. See BOBBIN-AND-FLY FRAME.

E-qua'tion-watch. A watch made to exhibit the differences between mean solar and apparent solar time. Originally made in England, but improved in France.

E'qua-to'ri-al. A telescope mounted to follow the apparent motion of the heavenly bodies as they move in the sky. It revolves about an axis so inclined that its motion around it may be parallel to the equator. Hence the name. See TELESCOPE.

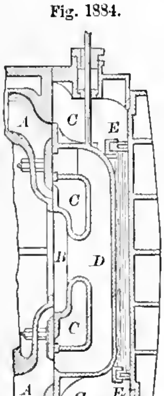
E'qua-to'ri-al Sec'tor. An instrument of large radius for finding the difference in the right ascension and declination of two heavenly bodies.

E'qua-to'ri-al Tel'e-scope. The equatorial telescope is so mounted as to have a motion in two planes at right angles to each other; one parallel to the axis of the earth, and the other to the equator. Each axis has a graduated circle, one for measuring declination and the other right ascension. The right ascension and declination of an astronomical object being known, the telescope may be pointed to the spot. Clock-work is sometimes attached to the instrument to give the motion in right ascension, and thereby keep the object constantly in the field of the instrument.

The large telescopes of the principal observatories are mounted equatorially. See TELESCOPE. See also Fig. 401, p. 175.

E'qui-lib'ri-um-valve. (*Steam-engine.*) *a.* A valve having a pressure nearly equal on both sides, so as to make it more easily worked by nearly neutralizing its pressure on the seat.

Fig. 1884.



Equilibrium-Valve.

The valve *D* has packing on the back opposite to the two ports, so as to exclude the steam from behind it, and thus remove the pressure thereof.

A, cylinder ports.

B, central port leading to condenser.

C, parts of the valve-casing filled with steam.

D, equilibrium-valve.

E, packing ring on the back of the valve.

b. The valve in the steam-passage of a Cornish engine for opening the communication between the top and bottom of the cylinder, to render the pressure equal on both sides of the piston.

E-ras'ing-knife. A knife with a cordate blade, sharpened on each edge, and adapted for erasing marks from paper by an abrading or cutting action, according to the angle at which it is held. The ends are provided with burnishers, rubbers, pencil-sharpeners, or other appendages useful about the desk. An *eraser.*

E-rect'ing Eye-piece. (*Optics.*) A combination of four lenses used for terrestrial telescopes, and so arranged as to exhibit the objects viewed in an erect position. This is not deemed necessary in astronomical telescopes, as the additional lens required causes the reflection and absorption of a certain portion of light.

E-rect'ing-glass. A tube with two lenses, slipped into the inner end of the draw-tube of a microscope, and serving to erect the inverted image. See ERECTOR.

E-rect'ing-prism. A contrivance of Nachet's for erecting the inverted image produced by a compound microscope, by means of a single rectangular prism placed over the eye-piece.

E-rect'or. An arrangement to antagonize the inversion of the image formed by the object-glass, by again inverting the image to make it correspond in position with the object.

First applied to compound microscopes by Lister. It is a tube about three inches long, having a meniscus at one end and a plano-convex lens at the other, — the convex sides upward in each case, — and a diaphragm about half-way between them. The *erector* is screwed into the lower end of the draw-tube.

E'ri-om'e-ter. An instrument for measuring the diameter of small fibers, such as wool, cotton, or flax, by ascertaining the diameter of any one of the colored rings which they produce.

"The *eriometer* is formed of a piece of card or plate of brass, having an aperture of about one fiftieth of an inch in diameter in the center of a circle of one half inch in diameter, and perforated with small holes. The fiber or particle to be measured is fixed in a slider, and the eriometer being placed before a strong light, and the eye assisted by a lens applied behind the small hole, the rings of colors will be seen. The slider must then be drawn out or pushed in till the limit of the first red and green ring (the one selected by Dr. Young) coincides with the circle of perforations, and the index will then show on the scale the size of the particle or fiber." — BREWSTER'S *Optics.*

Es-cape'. (*Telegraphy.*) Leakage of current from the line-wire to ground, caused usually by defective insulation and contact with partial conductors.

Es-cape'ment. A device intervening between the *power* and the *time-measurer* in a clock or watch, to convert a continuous rotary into an oscillating isochronous movement. It is acted on by each. The *power* imparts through the escapement an impulse to the *pendulum* or *balance-wheel* sufficient to overcome the friction of the latter and the resistance of the atmosphere, and thus keeps up the vibrations. The *time-measurer* (*pendulum* or *balance-wheel*) acts through the escapement to cause the motion of the *train* to be intermittent.

While there is some variation in the trains of clocks and watches, and in other particulars, they are generally named according to the form of their escapement; as, —

Anchor-escapement.	Detached escapement.
Chronometer-escapement.	Duplex-escapement.
Crown-wheel escapement.	Electric-clock escapement.
Cylinder-escapement.	Horizontal escapement.
Dead-beat escapement.	Lever-escapement.

Recoil-escapement.
Remontoire-escapement.
Verge-escapement.
Vertical escapement.
(Which see.)

Goodrich, in 1799, substituted a crank for an escapement in clocks, and received a bounty of £65 from the London Society of Arts. Its advantage was silence.

A number of curious and ingenious escapements may be found in works on horology, in Denison's volume in Weale's series; Brown's "Five Hundred and Seven Mechanical Movements"; and Piaget's "The Watch; its History and Manufacture."

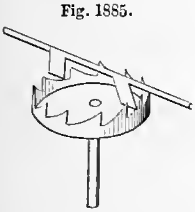
Es-cape′-valve. (*Steam-engine.*) *a.* A loaded valve fitted to the end of the cylinder for the escape of the condensed steam, or of water carried mechanically from the boilers with the steam. A *priming* valve.

b. Escape-valves are also fitted to the feed-pipes as a means of exit for the surplus water not used by the boilers.

c. A valve which affords escape to steam in a given contingency; upon excessive pressure by a safety-valve; to announce low-water, etc.

Es-cape′-wheel. These are various in form; the wheel is acted upon by the spring or weight of the clock or watch, and is allowed an intermittent rotation, one tooth at a time, and the pendulum or balance-wheel which thus regulates the movement becomes the time-measurer. The pallets on the oscillating pendulum arbor allow the teeth to escape, one at a time. See ESCAPEMENT.

Fig. 1885.



Verge-Escapement.

Es-carp′. (*Fortification.*) A wall on the inside of the ditch at the foot of the rampart. On the other side of the ditch is the *counterscarp.*

Es′cri-toire′. A writing-desk; generally fixed, and having a falling leaf.

Es-cutch′eon; Scutch′eon. An ornamental plate for a name, as in a *coffin-plate*, the *name-plate* on the side of a pocket-knife, etc.; or a perforated plate to finish an opening, as the *key-hole plate* of a door, drawer, or desk.

E-soph′a-gus-for′ceps. One for removing foreign matters from the gullet.

An esophagus-forceps, with bent shank, was found in 1819, in a house in Pompeii, by Dr. Savenko, of St. Petersburg. It is pictured in Smith's "Dictionary of Antiquities," p. 274.

Es-pal′ier. (*Agriculture.*) A trellis for training vines or other plants.

Es′pla-nade′. (*Fortification.*) An extended glacis. The sloping of the parapet of the covered way toward the open country.

A clear space between the citadel and the adjacent houses of a fortified town.

Es′ta-cade′. (*Fortification.*) A line of pile stakes in water or swampy ground to check the approach of an enemy.

Es-the′si-om′e-ter. (*Surgical.*) An instrument to ascertain the tactile sensibility of the human body. It has two points, adjustable as to distance, and the object is to ascertain the nearest proximity at which the points give distinct sensations. The result is indicative of a normal or abnormal condition of the surface. In front of the ear the points may be three quarters of an inch apart, and give but a single sensation; but if you draw them lightly across the face to the other ear, at a certain point the single sensation will change into a double sensation; as they approach the mouth, they will seem to separate more widely, and on the other side of the face they will seem to draw together again, until the double impression is lost in a single one. (See NERVE-NEEDLE.) An anatomist (Rufus, of Ephesus) dissected apes and distinguished between nerves of sensation and of motion.

Es-trade′. A slightly raised platform, occupying a part of a room. It may form a *dais.*

Et′a-gère′. A set of shelves in the form of an ornamental standing-piece of furniture. Used for the display of articles of bijouterie and vertu.

Etch′ing. 1. (*On metal.*) Engraving executed by a pointed tool and acid upon a metallic or glass surface previously covered with varnish.

The ordinary procedure is as follows: Cover a polished metallic plate with a composition technically called *ground*, and consisting of asphaltum, 4 parts; Burgundy pitch, 2 parts; white wax, 1 part. For use, this is melted and compounded, and tied up in a silk rag. The plate is heated, rubbed with the ground, which is then spread evenly, smoked, and allowed to cool.

The design is traced by a pointed tool, called an etching-point, which lays bare the metal wherever it goes. This finished, a wall of wax is raised around the design to hold the dilute acid which is poured on. For a copper-plate, this consists of nitrous acid, 1 part; water, 5 parts. For steel, pyroligneous acid, 1 part; nitric acid, 1 part; water, 6 parts. This is poured on the plate, which it corrodes on the lines made through the "ground." This is called "biting-in." The etching is swept with a feather to remove the bubbles from the surface, or, in case of a steel-plate, agitation may answer the purpose. When a sufficient depth is attained for the lighter tints of the etching, the acid is removed, the surface washed and allowed to drain dry. The parts having sufficient depth are now "stopped out" by a varnish of Brunswick-black laid on with a camel's-hair brush. When the varnish is dry, another "biting-in" will deepen the lines of the parts not "stopped out," and when these parts are deep enough for the second tint, the varnish is removed, the plate dried, etc. This is repeated as many times as may be necessary.

The wall of wax is then removed, the surface of the plate cleaned with turpentine, and the plate is sent to the printer for a proof of the etching, which is complete. It may be finished by a graver to give it more effectiveness, but it then partakes of the character of a line engraving.

Etching is *all* accomplished by the point and acid.

The art is believed to have originated in Germany, judging by its name *etzen*; but the earliest known practitioners were Albert Dürer, a German, and Agostino Veneziano and Parmegiano, Italians. These were contemporaries.

Etching on soft ground is in imitation of chalk or pencil drawing, but has been abandoned since lithography has attained excellence. The soft ground is made by adding one part of hog's lard to three parts etching *ground* (see GROUND), which is laid on the plate with the dabber in the usual way. A piece of smooth writing-paper, having the design in outline, is damped and stretched over the plate. A pencil is then used to follow the lines of the design, observing that the softer the *ground* the softer the pencil should be. The temperature of the season or the room will affect the character of the *ground.* When the paper is removed, it withdraws the adhering lines of ground, and the plate is *bitten-in* in the usual way.

Several peculiar processes have been introduced in etching, but are rather curious than useful.

Electro-etching, so called, is a process of *biting-in*, rather than *etching*, and consists in exposing the etched plate in the electro-bath, as the copper of the battery, so as to be corroded by the voltaic action. See ELECTRO-ETCHING.

Daguerreotype-etching is a process wherein the dark lines of the image in the camera are made to expose the plate to the action of acid.

One mode of etching, the reverse of the usual plan, is to remove with point and scraper the lights, and then bite-in so as to expose the design in relief.

2. (*Glass.*) Fluoric acid was discovered by Scheele in 1771. One hundred years previous to this, Schwanhard had a secret process for etching glass, but his secret died with him. See ETCHING ON GLASS.

3. (*Lithographing.*) *a.* The preparation of a lithographic stone with a weak mineral acid after the drawing or transfer has been put upon its surface; the object being to fix and render such drawing capable of receiving the ink used in printing. The crayon or ink of the artist is essentially based upon an alkaline soap combined with wax, resins, and pigment, the latter being added merely for the purpose of enabling the artist to see the progress of the work; drawings made with crayons and the ink used in pen-work are soluble, and hence not fit to resist the damping process on the stone; nor is the stone under them fit to receive the printing-ink. The action of a very weak acid applied to the stone by a large soft brush, a sponge, or by flooding it, is to decompose the alkaline soaps, forming nitrates or chlorides of the alkaline metals, according to the acid used, and setting free the stearic and oleic acids simultaneously. These fatty acids isolated in intimate contact with the carbonate of lime, of which the stone is mainly composed, appear to enter into chemical combination with the same, driving out the carbonic acid. The insoluble lime-soap thus formed has an exceedingly strong affinity for greasy matters of all kinds, and readily accumulates upon its surface the "varnish" (burned linseed-oil) constituting the vehicle carrying the carbonaceous matter which gives the printing-ink its color.

Another function of the weak acid is performed upon the clean part of the stone, whereby it renders the particles of calcareous matter peculiarly susceptible to receiving and holding, despite the long-continued damping operations upon the stone, the covering of gum-arabic furnished by the operation of GUMMING (which see). The gum is often applied with the acidulous solution. Sulphuric acid cannot be used in etching, in consequence of the production of insoluble sulphate of lime.

b. Etching by a needle or diamond on stone is done in two ways: —

1. The surface of the stone is treated with gum and acid (an ink-resisting compound), and dried; the work is then scratched in by the etching-point. Oil is rubbed over the surface, which is resisted by the gum, but penetrates where the stone has been laid bare by the needle. The stone is then washed off, rolled up and printed. This is usually called engraving.

2. The surface of the stone is covered with an asphaltum ground; the work is etched in, cutting away so much of the ground and exposing the stone. Acid is then applied, which eats away the stone, making a depression; this is inked, the asphaltum cleaned off, the clear spaces etched, and gummed as usual in the lithographic process.

Etch'ing-nee'dle. A sharp-pointed instrument for scratching away the *ground* on a prepared plate, preparatory to the *biting-in*.

Etch'ing on Glass. This art was invented by Schwanhard of Nuremberg, 1670, and originated in an accident to his spectacles, which became corroded by some drops of acid. Fluoric acid, discovered by Scheele, 1771, is now employed for corroding, or, as it is technically called, "biting-in" the etching. The glass is covered with a resinous ground, and the design marked by an etching-point, exposing the glass. The latter is then subjected to an acid, which acts upon the silicate and eats away the glass at these points, making depressions which constitute the etching.

Etch'ing-point. The steel or diamond point of the etcher.

Etch'ing-var'nish. A compound of wax, asphaltum, pitch, etc., for spreading on plates which are to be etched. See GROUND.

E'ther-en'gine. See BISULPHIDE OF CARBON ENGINE; AIR-ENGINE; GAS-ENGINE.

E-tui'. A case for holding small articles, as a lady's work-box and case for articles of graceful needle-work.

Eu'di-om'e-ter. Dr. Priestley, the discoverer of oxygen gas, devised the first *eudiometer*, for ascertaining the quantity of oxygen contained in a given bulk of aëriform fluid.

His device was founded upon the idea of subjecting a measured volume of air to a substance which would *absorb* the oxygen of the air. For this purpose he used deutoxide of nitrogen, which has an energetic tendency to regain the oxygen of which it has been deprived, and resume its condition as nitric acid.

Scheele's eudiometer was a tube of known capacity, in which a body of air was exposed to a mixture of sulphur and iron filings made into a paste with water. This abstracted the oxygen of the air, but an evolution of hydrogen somewhat marred the accuracy of the result.

De Marte used as an oxygen absorbent a solution of sulphuret of potassium.

Guyton used the same material, and added heat to expedite the result. See "Nicholson's Journal," 4to, Vol. I.

Seguin used a glass tube filled with and inverted in mercury. A piece of phosphorus, being introduced, floated to the top of the mercury, and was melted by the approach of a hot iron. Air is then introduced in instalments, and, igniting the phosphorus, parts with its oxygen thereto. A measured quantity having been thus introduced, the remainder in the tube is transferred to a graduated tube, and the loss of bulk by oxidation is determined.

Berthollet used the slow combustion of phosphorus, dispensing with the application of artificial heat.

Hope contrived a *eudiometer* in which a graduated tube containing a cubic inch of air was inverted into a phial containing the oxygen-absorbing solution. The apparatus, being tight, permitted the contents to be agitated. As gas was absorbed, water was admitted to the phial, and the rise of the liquid in the graduated tube indicated the amount of the gaseous remainder.

Henry substituted a caoutchouc ball for the phial in Hope's instrument.

Pepys made a number of technical improvements, which he considered insured accuracy, but certainly complicated the apparatus.

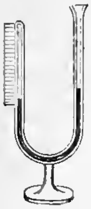
Volta introduced an instrument which superseded the preceding. He determined the composition of the air by combustion with a known quantity of hydrogen gas.

It is founded on the principle that when a mixture of oxygen and hydrogen gases is fired, one third of the diminution is owing to the condensation of oxygen. For this purpose he used a graduated tube and two platinum points, between which an electric spark was caused to pass.

This was modified in construction by Mitscherlich and others, retaining the main idea.

Ure's eudiometer is founded on the Volta principle, but is much simplified in point of manipulation. It consists of a graduated glass siphon whose open extremity is slightly flaring. The other end is closed, and has two platinum wires. Being filled with water or mercury, the closed leg receives a volume of gas by the ordinary means. A couple of inches of water being displaced from the open end of the tube, the mouth is closed by the thumb, and the instrument approached to the electric conductor, a spark from which, leaping the interval between the end wires, explodes the gases. The rise of the water in the closed end indicates the volume removed, and the result is determined, as before explained, by reference to the graduated tube. If merely oxygen and hydrogen gases have been introduced in their proper atomic proportions, eight of the former and one of the latter, by weight, the result will be water without gaseous remainder.

Fig. 1886.



Ure's Eudiometer.

If the experiment be as first stated: A given volume of hydrogen introduced in company with a body of atmospheric air to be tested; one third the amount of condensation may be ascribed to the removal of oxygen, whose proportions for combining with hydrogen to form water are, oxygen 1, hydrogen 2, by bulk.

The space between the thumb and the surface of the water in the open leg forms an air-cushion when the gases explode.

Döbereiner's is founded upon the power of spongy platinum to cause the combination of oxygen and hydrogen gas. The labors of Bunsen, Regnault, and Reiset, Williamson and Russell, Franklin and Ward, have brought the instrument to the present efficient form.

Eu′phroe. A long slat of wood, perforated for the passage of the awning-cords which suspend the ridge of an awning. The *euphroe* (or *uphroe*) and its pendent cords form a *crow-foot*.

Eu′style. (*Architecture.*) That style of intercolumniation in which the space between the columns was 2¼ times their diameter; so called from being considered the most beautiful style.

E-vap′o-rat′ing-cone. A Belgian evaporator, consisting of a hollow cone with double walls, between which is a body of steam. Over the inner and outer surface of the cone a saccharine solution runs in a thin film, and is thereby heated. It is similar in principle to the *Degrand condenser*. See CONDENSER; EVAPORATOR.

It is the same in its principle of construction as certain coolers, in which a refrigerating liquid fills the jacket, over whose walls passes the liquid to be cooled.

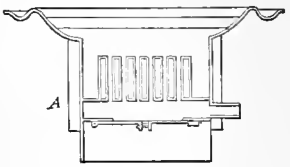
E-vap′o-rat′ing-fur′nace. The furnace of a boiler for cane-juice, sirup, brine, etc.

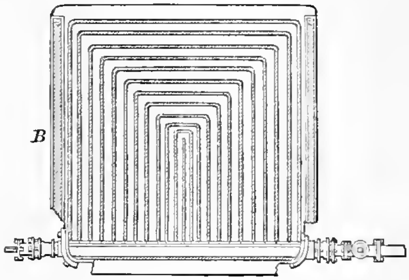
E-vap′o-ra′tion-gage. A graduated glass measure, with wire-gauze cover to prevent access of insects, to determine the ratio of evaporation in a given exposure.

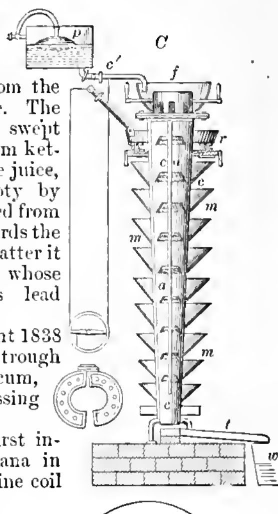
E-vap′o-ra-tor. An apparatus consisting of a furnace and pan, in which vegetable juices are condensed. The varieties are numerous: intended for the sugar-house of the plantation, that of the refinery; for maple-sugar making and for sorghum; for making vegetable extracts for medicines and other purposes. Those which boil *in* (partial) *vacuo* are known as VACUUM-PANS (which see). Some drive off a part of the aqueous fluid, and are called *condensers*, such as the Degrand. See CONDENSER.

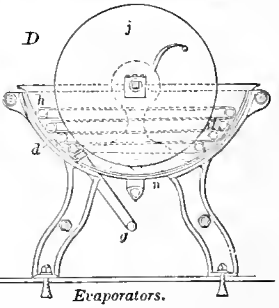
A "set of kettles" in Louisiana consists of five, placed in line, and with their tops on the same level. Underneath is a furnace, the mouth of which is outside the building. The kettles are technically known as the *grande*, *propre*, *flambeau*, *sirop*, and the *batterie*. The *grande* receives the cane-juice from the mill, and is the farthest removed from the mouth of the furnace. The scum, as it rises, is swept towards the rear from kettle to kettle, and the juice, as the kettles empty by evaporation, is dipped from one to the other towards the *batterie*. From the latter it is dipped into a box whose conducting troughs lead it to the *coolers*.

Fig. 1887.









Evaporators.

Hoard's pan, patent 1838 (*A*, Fig. 1887), has a trough around to collect scum, and tubular flues passing through the boiler.

The steam-pan, first introduced in Louisiana in 1829, had a serpentine coil at the bottom of a circular pan.

Stillman's pan (*B*), 1846, had a series of bends connecting with a tube which also formed an axis for the system which could thus be erected so as to expose the bottom of the pan.

A combination of the open pan and vacuum-pan has been adopted to some extent in Louisiana, and probably elsewhere. The cane-juice being concentrated in open kettles to about 26° or 28° Baumé and then finished in the vacuum-pan. It requires no special notice.

The Duplessis plan, 1846, consists in heating the juice in pans with double bottoms, forming steam-jackets, and then finishing it in kettles let into the top of a horizontal cylindrical boiler, which is pierced with holes for that purpose. The flanges of the kettles are bolted steam-tight to the top plate of the steam-boiler, which has an inclination from front to rear to facilitate the transfer of the scum to a trough at the lower end.

Graham's apparatus, 1843, has a series of kettles in a rising order towards the rear, like steps, so that the *grande* may empty into the *flambeau*, that into the *sirop*, and the latter into the *batterie*, without dipping. They are of progressively smaller size to the lower end of the series, and are heated by steam-jackets. The pans are connected by pipes furnished with stop-cocks.

A connected history of the process of manufacturing sugar is given under SUGAR-MANUFACTURING, and some things are omitted in this to avoid duplication. See also CONDENSER, DEGRAND, which acts as an evaporator of the sirup poured over it, while it condenses the vapor from the vacuum-pan with which it is charged. See VACUUM-PAN.

The Wetzel pan is heated by steam. It is a long tank with a semi-cylindrical lower portion in which revolves a hollow wheel heated by a constant flow of steam. Drums on the shaft are also full of steam, and are connected by pipes, steam-heated. Revolving slowly, it exposes a considerable surface to and agitates the sirup, which constantly drips off that portion exposed to the air.

The Bour pan is somewhat similar, but the revolving, heating surface is made up of steam-heated drums on a shaft, revolving in a pan having a semi-cylindrical well.

The evaporating cone *C* of Lembeck, near Brussels, consists of a double-walled cone *c c* about 16 feet high, and heated by steam in the space intervening between the walls. Sirup from the cistern *s* flows by the faucet *c'* into the funnel *f*, and thence is distributed by openings so as to run in a thin film over the interior surface of the cone *c*. A ball-cock keeps a constant level in the cistern *p*. To prevent the liquid running in streams down the surface of the cone, it is again and again arrested by the hollow conical frustums, which divide any trickling streams and redistribute them over the heated surface. These frustums are strung upon a stem *a a*, so as to be removed in a body when required for cleansing.

The exterior surface of the cone receives a film of the sirup from the same cistern, the spout conducting it into the trough *r* from whence it reaches the surface of the cone. It is again and again arrested by exterior funnel-shaped troughs *m m*, and allowed to trickle therefrom at openings along the meeting edge of the trough with the cone. This breaks up any determination to run in streams, and keeps the evaporating surface evenly supplied.

An annular reservoir receives the condensed liquid, whence it is conducted by a spout *t* to a cistern *w*.

The apparatus is especially designed for beet-root sugar-making.

The Degrand or Derosne condenser is an evaporator used in the cane-sugar works, and consists of a column of horizontal, steam-heated pipes over which the cane-juice trickles, and eventually passes in a condensed condition into a cistern below. See CONDENSER.

A class of inventions known as *coolers* agree in many points of construction with these surface condensers; the main difference being in the fact that in one case the hollow trunk is filled with a refrigerating liquid and in the other with steam. Useful hints may be taken from BEER-COOLERS; LIQUID-COOLERS (which see).

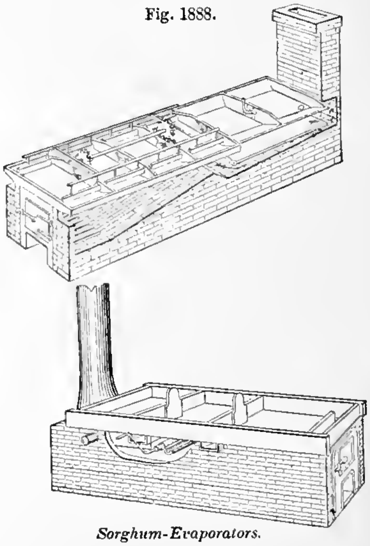
One form of apparatus consists of a number of hollow disks of lenticular figure, arranged upon a common axis, and dipping into the liquid to be evaporated. These disks, or lenses, are constructed of thin metal, and are all in communication with each other through the common axis, which is likewise hollow. The whole system is kept in slow rotary motion by some convenient moving power, and each disk carries up with it, adhering to its surface, a thin film of the liquid; as evaporation when it takes place without ebullition goes on with a rapidity proportional to the surface exposed.

Of this class is Schroder's evaporator *D*, used in the West Indies, for evaporating saccharine juices at a temperature not exceeding 180°; it is worked by hand or steam power. It is intended specially as a substitute for the *teache*, and consists of a semi-cylindrical pan *h*, whose contents are heated by a steam coil *d d*, connecting by pipe *g* with the boiler.

On a longitudinal axle resting in boxes on the ends of the pan are a number of disks *j*, which are rotated by power applied to the crank. As these disks are alternately exposed to the sirup and to the air, the latter has free access to the moistened surface, and carries off the aqueous particles with considerable rapidity. *n* is the discharge-pipe, which is opened by a faucet in the usual manner. The machine stands isolated on the floor of the sugar-house, and is supported on an iron stand.

A modification of this plan is the Cleland evaporator (English), in which the rotating device consists of a spiral coil of steam-pipe receiving steam through the trunnions and immersed during a portion of its revolution in the sirup of the pan. It differs from the *Schroder* pan in the fact that the rotating device is hollow and steam-heated so as to make the action more energetic, the film of sirup on the coil being exposed to the heat of the interior steam and to the evaporative action of the surrounding atmosphere.

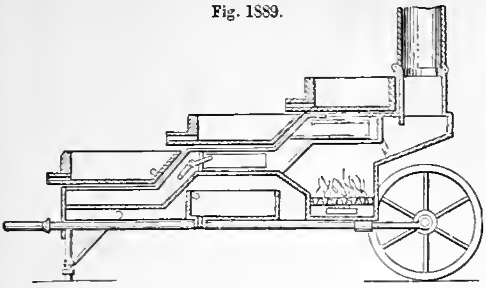
Fig. 1888.



Sorghum-Evaporators.

Fig. 1888 shows two forms of sorghum-evaporators, in the upper one of which are reciprocating paddles for removing scum from the heated juice and sweeping it towards the cooler overhanging shallower parts at the edges of the pan. The lower

Fig. 1889.



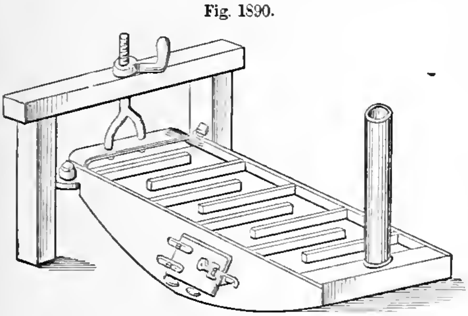
Portable Evaporator.

figure shows a series of pans with connecting apertures stopped by gates.

Fig. 1889 shows a portable evaporator mounted on a wheelbarrow.

Fig. 1890 shows an evaporator in which a continuous stream of juice is allowed to flow in a sinuous track from end to end of the pan, which is

Fig. 1890.

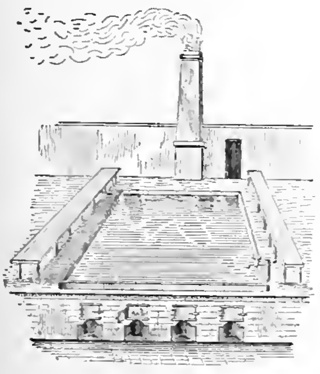


Continuous-Stream Evaporator.

so mounted as to be inclined in any required degree, according to the condition of the fire or of the juice, so that it may reach the end in the desired condition of condensation.

A pan for the evaporation of water from brine is an oblong square, and may have a depth of 12 to 16 inches, and an area of 20 × 40 feet. The pan is made of sheet-iron, supported on the division walls between the furnaces, which are in number proportioned to the width of the pan. The fire from the furnaces is conducted to heat-ovens before being discharged into the chimney. The brine is led into the pan by pipes, and under ordinary circumstances may be twice changed in twenty-four hours. As soon as most of the water has been evaporated, the wet salt is ladled into conical baskets which are placed against the bench to drain. The salt is finally dried in the ovens heated by the furnace fires.

Fig. 1891.



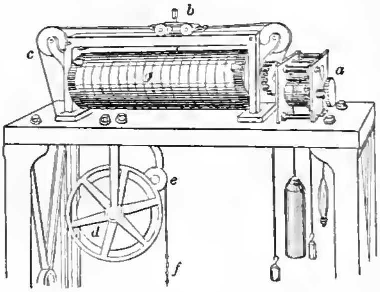
Salt-Pan.

The cocoa-nut palm yields a juice (*suri*), which is evaporated to make a sugar (*jaghery*), one gallon of *suri* yielding a pound of *jaghery*. This is five times the quantity to the gallon that is yielded by the sugar-maple. The suri is obtained by cutting the spadix of the tree and collecting the juice in a crock suspended from the spathe.

E-vap'o-rom'e-ter. An *atmometer* or *hygroscope*, for ascertaining the evaporation of liquids.

The example shows a self-recording evaporometer or tide-gage, adapted also for a rain-gage or to indicate the rise and fall of any body of water in a river, canal, or lock, showing the exact time at which any increase or reduction of level may have occurred.

Fig 1892.

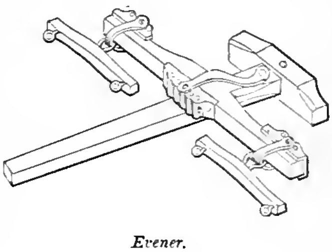


Evaporometer.

a is a time-piece driving the paper cylinder *g*; *b* is the carriage which carries the tracing-pencil that marks the paper on the cylinder, and is moved by the float which is suspended from the card *f* and rests on the surface of the water. The motion of the float is communicated by cord *f* over small wheel *c*, float-wheel *d*, and pulley *e*.

E'ven-er. A double or treble tree, to "even" or divide the work of pulling upon the respective horses. It is swiveled to the pole, usually by a bolt or wagon hammer, and has clips on the ends to which the middle clips of the single trees are attached.

Fig. 1893.



Evener.

Ev'er-point'ed Pen'cil. A pencil-case having a fine cylinder of graphite, which is brought forward by a screw as fast as wear renders it necessary.

Patented by Hawkins and Mordan, England, 1823. The pencil-case has a slider actuated by a screw to project a little cylinder of black-lead as the latter wears away. The lead is so small in diameter that it does not need cutting for the ordinary purposes of a pencil. The projection of the lead is performed by holding the nozzle in one hand and turning round the pencil-case with the other.

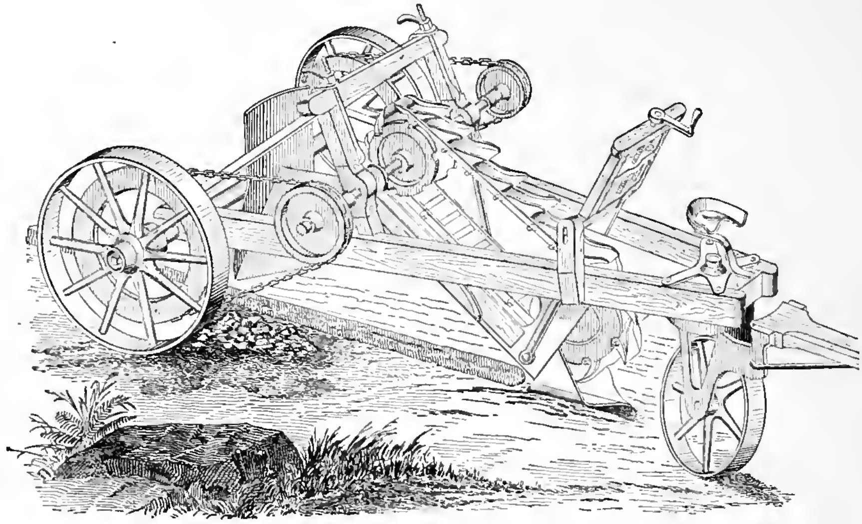
A reservoir at the end of the holder contains a supply of spare leads.

Ew'er. A toilet-pitcher with a wide spout.

Ex'ca-va tor. 1. A machine for digging earth and removing it from the hole. This definition does not distinguish the *excavator* from the *ditching-machine, auger, dredge, earth-borer, post-hole digger,* etc. Custom, however, confines the term *excavator* to a narrower range.

The excavator, which is of the nature of a plow, with an elevating earth-belt, is shown in Fig. 1894. It has adjustment for depth of cut, and the dirt ex-

Fig. 1894.

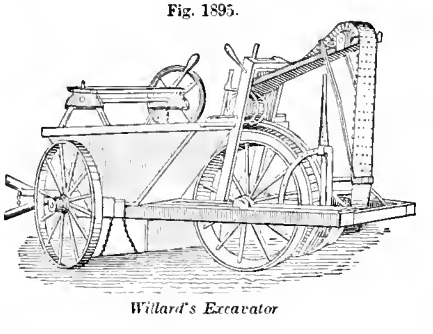


Ditch-Excavator.

cavated by the hollow share is carried upwardly and backwardly by the shovel-belt and dropped into the chute, which discharges it at the side of the trench.

Willard's excavator, which has been so widely used in making railway embankments in the broad West, is shown in Fig. 1895. Its principal use in practice has been to dig soil by the side of the track and dump it on to the road, to form a bed for the ballast and sleepers. The earth is scraped up by the shovel, carried between the wheel and a traveling apron, and dropped into a hopper. When this is full, the ma-

Fig. 1895.



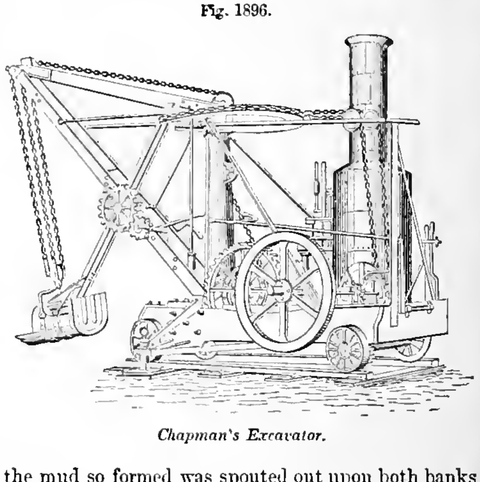
Willard's Excavator

chine is drawn on to the site of the road and the load dumped.

The excavator (Fig. 1896) is mounted on a carriage which traverses on a temporary track. At one end of the frame is a crane, which has a circular adjustment on its axial post. To the end of the chain-tackle is suspended a scoop made of boiler-iron, whose lip is a steel edge with fingers. Direction is given to the scoop by means of a beam which may be called the scoop-handle, and when the scoop has been thrust by its weight into the earth, the beam affords a fulcrum on which the scoop rotates when the tackle-chain is wound up on the drum by the action of the steam-engine.

The excavated earth along some parts of the line of the Suez Canal was transported by means of a pump. By the aid of a steam-pump water was mixed with the earth brought up by the dredge, and

Fig. 1896.



Chapman's Excavator.

the mud so formed was spouted out upon both banks of the canal to such a distance and in such quantities as to form high compact ramparts against the sand showers blowing in from the desert. Ninety-six million cubic yards of earth have been taken out; and there is left to-day a canal 90 miles long, 328 feet wide at the surface, and 74 feet wide at the bottom, and 26 feet deep throughout. See DREDGING-MACHINE.

The practice adopted in the United States, in France, in England, and Holland is to mix such earth *in situ* and pump it up, — mud, earth, sand, and all, — and pour it into lighters or directly upon the land adjacent.

The hydraulic mining of California is by means of powerful jets of water projected against the banks of drift, the *débris* of former periods of glacial and fluvial action. See AUGER; DITCHING-MACHINE; DREDGING-MACHINE; SCRAPER; WELL-BORING.

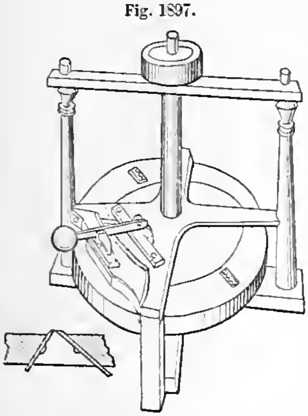
Number of Cubic Feet of various Earths in a Ton.

Loose earth	24
Coarse sand	18.6
Clay	18.6
Earth with gravel	17.8
Clay with gravel	14.4
Common soil	15.6

2. A dentist's instrument for removing the carious portion of a tooth. They are of various forms and sizes, straight, curved, angular, and hooked; and may be compared to chisels, gouges, scropers, scrapers; spear, hoe, hatchet, spade or spoon shaped, etc.

Ex-cel'si-or. A trade name for curled shreds of wood used as a substitute for curled hair in stuffing cushions, etc.

Fig. 1897.



Excelsior-Machine.

It is made in a machine in which the bolt is pressed downward within its fixed case by a weighted lever, and subjected to the action of the scoring and plane cutters at the upper surface of the horizontal rotating wheel.

Ex-change'-cap. A fine quality of paper made of new stock; thin, highly calendered, and used for printing bills of exchange, etc.

Ex-cla-ma'tion. Note of. A mark (!) indicating emotion or pointed address; as —

"Father of all!"

Ex-e'dra. (*Architecture.*) A niche projecting beyond the general plan of a building.

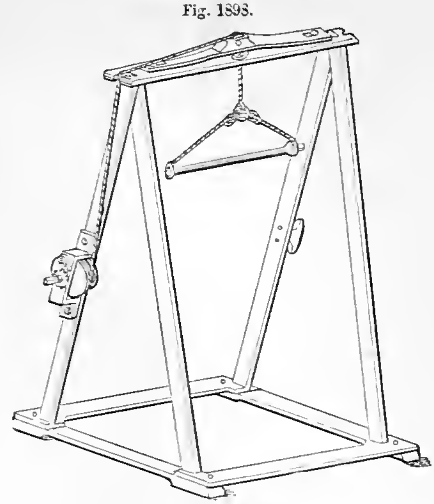
Ex'er-cis'ing-ap'pa-ra'tus. An apparatus for the use of gymnasts, or for the training of special muscles. In the example, the hand-bar is supported on an adjustable cord passing over a spring. The frame has two spring-boards near the floor.

In other instances the apparatus is intended for the use of those unable to take walking exercise. The bedridden patient uses the arms to flex and extend the legs and keep the body in motion, the bedstead rocking on its centers.

Lounde's English patent, 1796, described a *gymnasticon* with treadles for the feet and cranks for the arms. It is adapted to exercise a limb which may have no voluntary motion, and may be used by a patient sitting, standing, or lying.

Ex-haust'er. (*Gas-making.*) An apparatus by which reflex pressure of gas upon the retorts is prevented. The forms are various; one consists of a

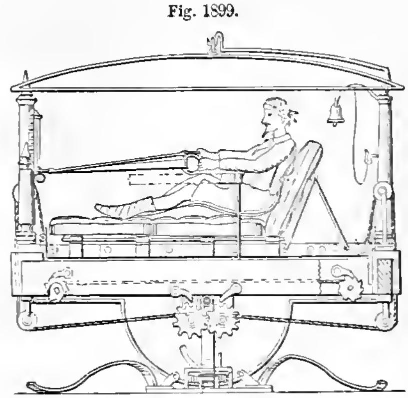
Fig. 1898.



Gymnasts' Machine.

device like one form of rotary steam-engine, which has an eccentric, revolving hub and sliding piston

Fig. 1899.



Exercising-Apparatus.

in a cylindrical chamber. It is of the nature of a rotary pump.

Ex-haust'-fan. One in which the circulation is obtained by *vacuum*, in contradistinction to that which acts by *plenum*, forcing a body of air into and through a chamber or passage-way. See BLOWER; FAN.

Ex-haust'ing-syr'inge. A syringe with its valves so arranged as to withdraw the air from the object to which it is applied.

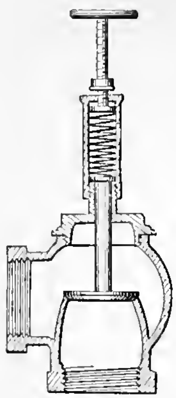
Ex-haust'-port. (*Steam-engine.*) The passage leading from the cylinder to the condenser or to the open air.

Ex-haust'-pipe. One conducting the spent steam from the cylinder.

Ex-haust'-reg'u-lat'or. A valve adjusted to the pressure of the steam by compressing or relaxing the spring held within the tube, by means of a disk secured to the end of the spindle, the object being to utilize the exhaust steam.

Ex-haust' Steam. (*Steam-engine.*) Steam which passes out of the cylinder after having performed its function. It is emitted by its own pressure when the exhaust-valve is opened, and its ejection is

Fig. 1900.



Exhaust-Regulator

assisted by the advancing piston, which is being driven by the *live steam* behind it.

Ex-haust′-valve. (*Steam-engine.*) The valve which governs the opening by which steam is allowed to escape. The *eduction-valve.*

The valve in the eduction passage of the steam cylinder of a Cornish engine, placed between the cylinder and air-pump, and worked by the tappet motion, so as to open shortly after the equilibrium-valve, and admit the steam to the condenser.

Ex-pand′ing-al-loy′. Such as expands in cooling. They always contain bismuth, and usually antimony. Type-metal is a familiar instance.

Ex-pand′ing-ball. One having a hollow conical base, affording a relatively thin body of metal, which is expanded by the force of the explosion, driving it closely against the bore of the gun and into the rifling, preventing windage.

Ex-pand′ing-bit. A boring-tool whose diameter is adjustable. See AUGER; BIT.

Ex-pand′ing-drill. One having a pair of bits which may be diverged at a given depth to widen a hole at a certain point; used in drills for metal and for rock-boring.

Ex-pand′ing-man′drel. One having fins expansible in radial slots to bind against the inside surfaces of rings, sleeves, or circular cutters placed thereon.

Ex-pand′ing-plow. One having two or more shares, which may be set more or less distant, according to the distances between the rows at which different crops are planted.

Ex-pand′ing-pul′ley. One whose perimeter is made expansible, as a means of varying the speed of the belt thereon. See EXPANSION-DRUM.

Ex-pand′ing-ream′er. One which has a bit or bits extensible radially after entering a hole, so as to enlarge the hole below the surface.

Ex-pan′sion. 1. The expansion and contraction of long beams from changes in temperature is shown by the following table, which exhibits the extension dilatation in passing from 32° to 212° Fah. (0° to 100° centigrade).

The table exhibits the expansion at 212°, the length of the bar at 32° = 1.

Bismuth	1.00139
Brass	1.00216
Copper	1.00181
Bronze	1.00184
Gold	1.0015
Cast-iron	1.00111
Wrought-iron	1.00125
Steel	1.0011
Lead	1.0029
Platinum	1.0009
Silver	1.002
Tin	1.002
Zinc	1.00294
Brick, common	1.00355
Brick, fire	1.0005
Cement	1.00143
Glass (average)	1.0009
Granite	1.0008
Marble	1.0011
Sandstone	1.0017
Slate	1.00104
Pine (along the grain; dry)	1.000428
Honduras Bay wood (along the grain; dry)	1.000461
Water at 40° = 1	1.0401
Air	1.376

2. (*Shipbuilding.*) The expansion of the skin of a ship, or rather of a net-work of lines on that surface, is a process of drafting to facilitate the laying-off of the dimensions and positions of the pieces of which that skin is to be made, whether timber planks or iron plates.

It consists in covering the surface with a net-work of two sets of covers, which cross each other so as to form four-sided meshes; then conceiving the sides of those meshes to be inextensible strings, and drawing the net-work as it would appear if spread flat upon a plane. By this operation, the meshes are both distorted and altered in area; the curves forming the net-work preserve their true lengths, but not their true angles of intersection; and all other lines on the surface are altered both in length and in relative angular position.

The process is applied to surfaces not truly developable. See DEVELOPMENT.

3. (*Steam.*) The principle of working steam expansively was discovered by Watt, and was the subject-matter of his patent of 1782. By it the supply of steam from the boiler to the cylinder is *cut off* when the latter is only partially filled, the remainder of the stroke of the piston being completed by the expansion of the steam already admitted.

The work done by a given amount of steam is greater when worked expansively than when worked at full pressure, in the following ratio: —

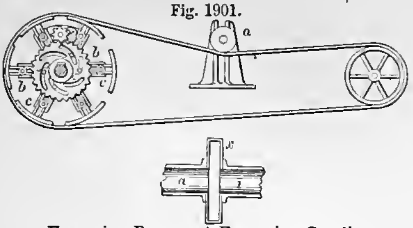
Point of cutting off.	Mean Pressure of Steam.	Gain per Cent in Power.	Point of cutting off.	Mean Pressure of Steam.	Gain per Cent in Power.
.1	3.302	230.	.5	1.693	69.3
.125	3.079	208.	.6	1.507	50.7
.166	2.791	179.	.625	1.47	47.
.2	2.609	161.	.666	1.405	40.5
.25	2.386	139.	.7	1.351	35.1
.3	2.203	120.	.75	1.285	22.3
.333	2.099	110.	.8	1.223	20.5
.375	1.978	97.8	.875	1.131	13.1
.4	1.916	91.6	.9	1.104	10.4

No deductions are here made for a reduction of the temperature of the steam while expanding or for loss by back pressure.

Ex-pan′sion-coup′ling. The coupling represented consists of an expansion-drum of thin copper *x* between the extremities of two pipes *a i*, Fig. 1901, which, in elongating, press the sides of the drum in, and draw them out in cooling.

Ex-pan′sion-drum. An arrangement by which an occasional change of speed may be effected. The diameter of one of the drums is made variable, and the belt is kept strained by means of the weighted roller *a*. The part of the *expansion-drum* marked *b*, consisting of a boss and grooved arms, is keyed fast on the shaft; on to another portion of the arm *c*, which slides up and down, in the groove of *b*, is cast a portion of the circumference of the drum; it has also a stud *d*, fitting into the curved slot of the disk *e*, which moves loose on the boss *b*, and has teeth on its circumference into which works a pinion *f*, with ratchet fixed to the part *b*, and turned with a handle. As the disk is to turned the right or

Fig. 1901.



Expansion-Drum and Expansion-Coupling.

left, the studs move up or down in the curved slots, and the diameter of the drum is increased or diminished.

Ex-pan'sion-gear. (*Steam-engine.*) The apparatus by which access of steam to the cylinder is cut off at a given part of the stroke. A *cut-off.*

A *variable* cut-off is one which is capable of being adjusted while the engine is in motion, to cut off at any given portion of the stroke, within a given range, as the requirements of the work may indicate.

A *fixed* expansion is one arranged to cut off at a determinate part of the stroke.

An *automatic* expansion is one which is regulated by the governor, and varies with the amount of power required.

The expansion gear of marine engines generally consists of a graduated *cam* on the paddle-shaft, against which a *roller* presses and communicates the movement peculiar to the irregular surface of the cam, through a series of rods and levers, to the *expansion-valve* situated between the throttle-valve and the slides. See EXPANSION-VALVE.

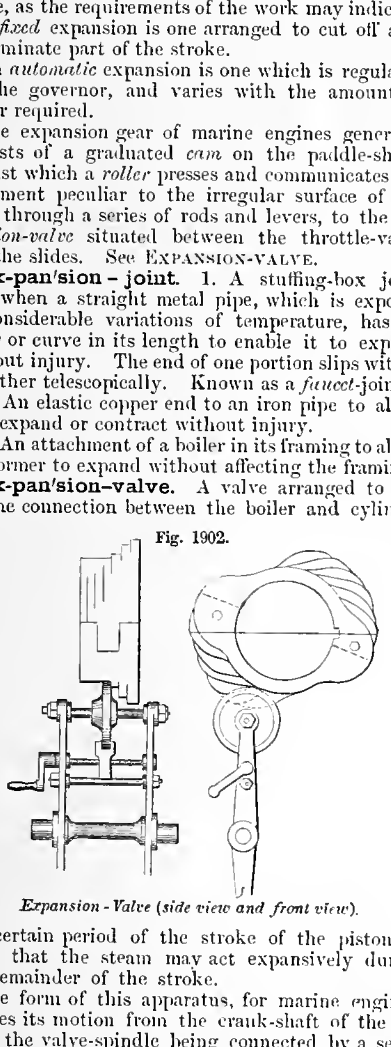
Ex-pan'sion-joint. 1. A stuffing-box joint used when a straight metal pipe, which is exposed to considerable variations of temperature, has no *elbow* or curve in its length to enable it to expand without injury. The end of one portion slips within the other telescopically. Known as a *faucet*-joint.

2. An elastic copper end to an iron pipe to allow it to expand or contract without injury.

3. An attachment of a boiler in its framing to allow the former to expand without affecting the framing.

Ex-pan'sion-valve. A valve arranged to cut off the connection between the boiler and cylinder

Fig. 1902.



Expansion-Valve (side view and front view).

at a certain period of the stroke of the piston, in order that the steam may act expansively during the remainder of the stroke.

One form of this apparatus, for marine engines, derives its motion from the crank-shaft of the engine, the valve-spindle being connected by a series of rods and levers with a small brass pulley which presses against the periphery of a graduated cam on the crank-shaft, by which means the steam is "cut off" in the most advantageous manner at any required portion of the stroke. See CUT-OFF.

Ex'ple-tive-stone. (*Masonry.*) One used for filling a vacuity.

Ex-plor'er. An apparatus by which the bottom of a body of water is examined, when not beyond a certain depth.

In one form it is called a submarine telescope; in other forms it is a diving-bell, submarine-boat, etc. See ARMOR, SUBMARINE; DIVING-BELL; SUBMARINE-BOAT; SUBMARINE-TELESCOPE.

Ex-plo'sive-ball. One having a bursting-charge which is ignited on concussion or by time fuse. See SHELL.

Ex-plo'sives. Gunpowder was in use as far back as the twelfth century, and its composition, as shown by old manuscripts, did not differ greatly from the most approved modern manufacture. See GUNPOWDER.

Berthollet proposed to substitute chlorate of potash for saltpeter in the manufacture of gunpowder. The explosive force was in this way doubled, but it was found to explode too readily, and, at a trial in loading a mortar, at Essonnes, 1788, the powder exploded when struck by the rammer, blowing mortar and gunners to pieces.

Fulminates of gold, silver, and mercury were experimented with in the early part of this century, as substitutes for gunpowder. Fulminate of mercury is obtained by dissolving mercury in nitric acid and adding a certain proportion of alcohol and saltpeter to the mixture. It is used extensively in the manufacture of percussion-caps and cartridges, but none of the fulminates are likely to be used in large quantities, as being too expensive and dangerous. In an experiment at Paris, a grain of fulminate of gold was placed on an anvil and exploded by a blow from a sledge, making a dent in both hammer and anvil.

Pyroxyline, or gun-cotton, was discovered by Schoenbein in 1846. It is prepared by immersing cotton in a mixture of nitric and sulphuric acid for a few minutes, and then washing and drying it. It has been experimented with by several European nations in connection with fire-arms, but was found to be dangerous, and to rapidly destroy the arms by its excessive energy, and was abandoned by all but the Austrians, who utilized the improvements of Baron Lenk in gun-cotton, and have several batteries of artillery adapted to use the improved composition. Abel's English gun-cotton is now used for petards and in mining. Several compounds based on gun-cotton are used in the arts, as in collodion for photography, surgery, etc.

Nitro-glycerine, which is pure glycerine treated with nitric acid, was discovered by the Italian chemist Sobrero in 1847, but was very little used until 1863, when it was utilized by Nobel for blasting. The explosive energy of this compound is given as from four to thirteen times that of rifle powder. By an explosion of a few cans of this material on the wharf at Aspinwall in 1866, a considerable portion of the town was destroyed, shipping at some distance in the harbor much damaged, and a number of lives were lost. An explosion of a storehouse containing some hundreds of pounds of nitro-glycerine took place at Fairport, Ohio, in 1870, accompanied with much loss of life. The shock was felt at Buffalo, 160 miles distant.

Nobel, in 1867, invented a compound called dynamite, which consists of three parts nitro-glycerine and one part of porous earth. Dynamite is supposed to be safe against explosion from concussion or pressure. See DYNAMITE.

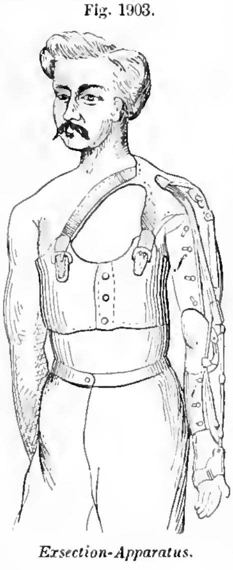
Dualine differs from dynamite in the employment of sawdust with nitro-glycerine, instead of earth or silica. See DUALIN.

Picrate of potash is a yellow salt, extremely explosive, formed from potassium, by the action of picric acid, a product of the distillation of coal-tar. It was experimented with by the French War Department to some extent, and was demonstrated to lie between gunpowder and dynamite in its explosive force.

M. Berthelot gives, in *Annales de Chimie et de Physique*, a table showing the relative force of explosives. From this table is deduced the following, expressed in terms of our own standard measurements: —

	Quantity of heat disengaged by one ounce.	Volume of gas formed.	Relative pressure developed, the pressure of hunting-powder being taken as unity.
	Heat units	Cubic feet.	
Hunting-powder	147,871	0 216	1
Cannon powder	140,215	0 225	0.986
Mining-powder	117,467	0.173	0.633
Mining-powder with excess of niter	155,472	0.111	0.540
Powder with nitrate of soda base	176,432	0.248	1.368
Powder with chlorate of potash base	224,889	0.318	2.225
Chloride of nitrogen	72,784	0.370	0 842
Nitro-glycerine	306,337	0.710	6.797
Gun-cotton	145,337	0 801	3.636
Gun-cotton mixed with nitrate	228,371	0.484	3.456
Gun-cotton mixed with chlorate	327,528	0.484	4.594
Picric acid	160,309	0 780	3.910
Picric acid mixed with nitrate	223,515	0.408	2.722
Picric acid mixed with chlorate	328,909	0 408	4.198
Picric acid mixed with oxide of lead	49,981	0 120	0.108
Picric acid mixed with oxide of copper	94,204	0.270	0.785
Picric acid mixed with oxide of silver	60,576	0.116	0.208
Picric acid mixed with oxide of mercury	43,762	0 212	0 288
Picrate of potash	135,663	0 585	2.476
Picrate of potash mixed with nitrate	197,161	0.337	2 059
Picrate of potash mixed with chlorate	328,449	0.337	3.574

Fig. 1903.



Exsection-Apparatus.

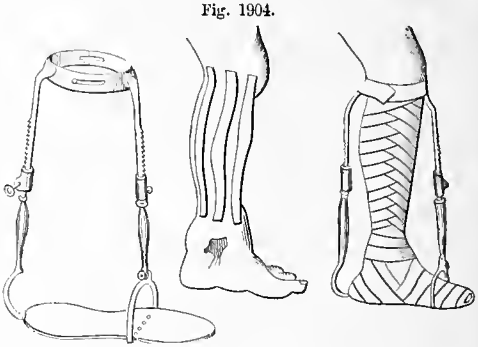
See —
Blasting.
Blasting-powder.
Dynamite.
Fulminate.
Fuse.
Gun-cotton.
Gunpowder.
Lithofracteur.
Nitrine.
Nitro-glycerine.
Nitroleum.
Percussion-powder.

Ex-sec'tion-ap'pa-ra'tus. (*Surgical.*) A splint or support to stiffen and aid an arm from which a section of bone has been removed. In the example, it has a scapula or saddle-pad which forms a foundation for the other parts, and from this proceed jointed rods and elastic bands, which form auxiliary bones and muscles. The humerus and the forearm have rigid cases which afford means of attachment for the prosthetic parts, and the cases are held to the arm by flexible aponeurotic bands *f i*.

Ex-tend'ed-let'ter. (*Printing.*) One having a face broader than usual with a letter of its hight.

Ex-ten'sion-ap'pa-ra'tus. (*Surgical.*) An instrument designed to counteract the natural tendency of the muscles to shorten when a limb has been fractured or dislocated. Ordinarily this is done by means of a weight and pulley attached to an arrangement surrounding the limb immediately

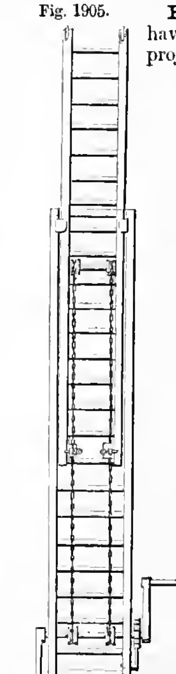
Fig. 1904.



Extension-Apparatus.

above the point of fracture; but in the apparatus shown in Fig. 1904 this is effected by screw-threaded rods, the lower one of which carries a plate applied beneath the sole of the foot and attached by a stirrup passing over the instep. It is obvious that this apparatus may be also adapted to dislocations or fractures of the humerus or forearm. See also COUNTER-EXTENSION.

Fig. 1905.



Ex-ten'sion-lad'der. A ladder having a movable section, which is projected in prolongation of the main

Fig. 1906.

Extension-Ladders

section when occasion requires. A common form is shown in Fig. 1905, in which the sections of the ladder slide upon each other, and the upper one is extended by chains which pass around rollers and are wound upon a windlass journaled to the lower section.

Another form has a standing base part. The ladder is formed of jointed sections, which may be folded together or arranged as a self-supporting ladder. Some ladders are mounted on trucks to be used in emergencies. See FIRE-ESCAPE.

Some of the Roman scaling-ladders were made in sections and put together to form a large ladder. Others of their ladders might be elevated with a man on the top for reconnoitering.

Ex-te'ri-or-screw. One cut upon the outside of a stem or mandrel, in contradistinction to one whose thread is cut on an interior or hollow surface.

Ex-te'ri-or-slope. (*Fortification.*) The slope of a parapet towards the country. It is at the foot of the *superior* slope, and forms the lower portion of the rampart above the *escarp*, or the *berme*, if there be one. See PARAPET.

Ex-tin'guish-er. A little cone placed on top of a burning candle to extinguish the light. Extinguishers were also formerly attached to the railings of city houses to enable the link-boys to dout their torches.

Some lamps have attachments which may be made to clasp the exposed portion of the wick and extinguish the flame.

Ex-tract'or. (*Surgical.*) An instrument for removing substances from the body. See BULLET-FORCEPS, etc.

Ex'tra-dos. The exterior curve of an arch, measured on the top of the voussoirs; as opposed to the *soffit* or *intrados*.

Eye. An opening through an object; as, —

1. (*Nautical.*) *a.* A circular loop in a shroud or rope. A worked circle or grommet in a hank, rope, or sail.

b. The loop of a block-strap.

c. The hole in the shank of an anchor to receive the ring.

2. (*Milling.*) The hole in a runner stone through which the grain passes to be ground.

3. The hole through the center of a wheel, to be occupied by the axle, axis, or shaft.

4. The eye of a crank; a hole bored to receive the shaft.

5. A metallic loop on the end of a trace, to go over the pin or hook on the end of a single-tree. A *cock-eye*.

6. (*Architecture.*) *a.* The circular aperture in the top of a dome or cupola.

b. The circle in the center of a volute scroll.

c. A circular or oval window.

7. The hole in the head of an eye-bolt.

8. The center of a target. A bull's-eye.

9. The thread-hole in a needle.

10. The loop in which the hook of a dress catches.

Eye, Ar'ti-fi'cial. 1. A shell or segment of a hollow sphere, usually made of enamel, and so inserted as to present the appearance of the natural eye.

Artificial eyes made of glass are found in ancient Egypt. In the Abbott Museum of Egyptian Antiquities, New York, are several wooden cats with glass eyes. One of them is but a shell, and contains the mummy of a cat. They are from the cat-tombs of Sakkarah.

Fig. 1907.

Artificial Eye.

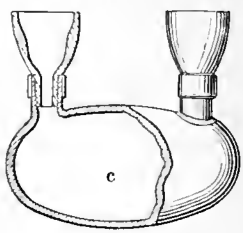
In the example (Fig. 1907), the caruncular portion of the ocular orbit has unguinal depressions on each side of the nasal extremity, so as to establish harmony between the circumference of the prosthetic shell and the organic sinuosities when used on either side.

2. (*Nautical.*) An eye worked into the end of rope, as a substitute for a spliced eye.

Eye-bolt. A bolt having an eye or loop at one end for the reception of a ring, hook, or rope, as may be required. The insertion of a closed ring into the eye converts it into a ring-bolt.

Eye-cup. A cup for washing the eyeball. Its lip is held firmly against the open lid, and the eye-wash dashed against the ball, or forced against it by compressing the reservoir, as in the example. The device shown is also applicable to the eyeball for the purpose of preventing myopia by preserving the convexity of the cornea; the bag *c*, being partially exhausted, is allowed to expand after the edges of the cups are seated upon the eye-balls.

Fig. 1908.



Eye-Cups.

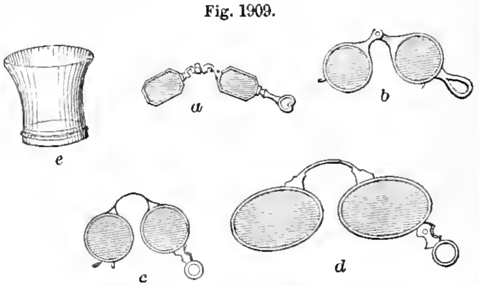
Eye-ex'tir-pa'tor. A surgical instrument for removing the eye.

Putting out the eyes has long been a common Oriental punishment. The eyes of Zedekiah were put out by Nebuchadnezzar. Xenophon states that in the time of the younger Cyrus the practice was so common that the blinded men were a common spectacle on the highways. The Kurds and Turkestan hordes yet blind their aged prisoners.

Eye-glass. 1. (*Optics.*) The glass nearest to the eye of those forming the combination eye-piece of a telescope or microscope. The other *glass*, nearer to the object-glass, is called the *field*-glass. See NEGATIVE EYE-PIECE.

2. A pair of glasses to aid the sight; usually worn by clasping the bridge of the nose. They are of various shapes, *a b c d*. The watchmaker's or engraver's eye-glass *c* has a horn frame and a single lens. Its flaring edge is retained within the ocular orbit by the muscular contraction of the eyelids.

Fig. 1909.



Eye-Glasses.

Eye-head'ed Bolt. A form of bolt having an eye at the head end. It is intended for securing together two objects at right angles, — as a gland to a stuffing-box, etc. See BOLT.

Eye-in'stru-ments.

Operative.	
Cataract-knife.	Ectropium.
Cataract-needle.	Entropium.
Couching-instrument.	Entropium-forceps.
	Eye-cup.

Eye-extirpator.
Eye-forceps.
Eyelid-dilator.
Eye-protector.
Eye-speculum.
Eye-syringe.
Iriankistrium.
Iridectomy-instrument.
Keratome.
Lachrymal-duct dilator.
Pterygium.
Strabismus-forceps.
Strabismus-scissors.

Examinative.
Auto-opthalmoscope.
Iridioscope.
Opsiometer.
Ophthalmometer.
Ophthalmoscope.
Ophthalmostate.

Prosthetic.
Eye. Artificial
Pupil. Artificial

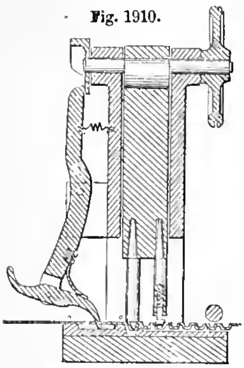
Optical.
Eye-glass.
Goggles.
Shades.
Spectacles.
See OPTICAL INSTRUMENTS.

Eye-lens. That one of the four lenses in an eye-piece which is nearest to the eye. The *eye-piece.*

Eye′let. A short metallic tube whose ends are flanged over against the surfaces of the object in which the said tube is inserted. It is used as a bushing or reïnforce for holes to prevent the tearing of the perforated edge of the fabric or material by the lacing.

Eyelets are made from strips of metal by a cutting and punching operation, or punching and shaping. In the example, the strip of eyelet metal is forwarded by the grasping jaws of a reciprocating lever, between the dies which form frusto-conical recesses, preliminary to annealing and punching.

Fig. 1910.



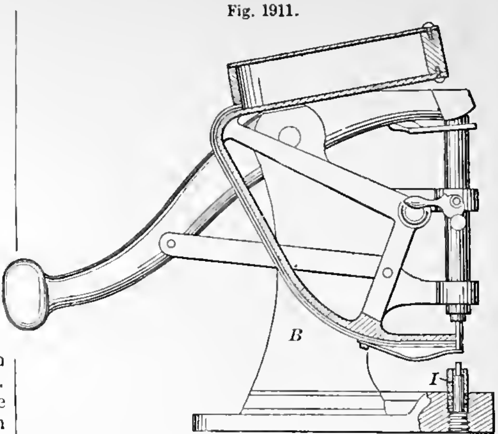
Eyelet-making Machine.

Eye′let-eer′. A stabbing instrument of the work-table, to pierce eyelet-holes. A *stiletto.*

Eye′let-ing-ma-chine′. A machine for attaching eyelets to garments or other objects.

The guide-pin within the punch takes the eyelets from the mouth of the feeding-chute *B*, said pin being subjected to the action of a spring having a tendency to force it out of the punch. When pushed in, the guide-pin is retained by a spring-catch which is automatically released as often as the punch reaches its highest position. The friction-spring retains the eyelets on the guide-pin till the punch forces them off. The anvil *I* has a projecting point, and is surrounded by an elastic tubular bed, so that the material to be eyeleted, on being forced over the point, is pierced and then supported by the elastic bed, which offers sufficient resistance to permit the eyelet to be forced through the hole.

Fig. 1911.



Eyeleting-Machine.

Eye′let-punch. A device used at the desk for attaching papers together by eyeleting. It has usually a hollow punch for making a hole, and a die-punch to upset the flange of the eyelet.

Eye′let-set′ting Ma-chine′. See EYELETING-MACHINE.

Eye-piece. (*Optics.*) An *eye-piece*, or *power*, as it is sometimes called, is the lens or combination of lenses used in microscopes or telescopes to examine the aërial image formed at the focus of the object-glass. — BRANDE.

Eye-pieces may be, —

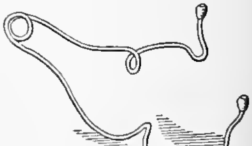
1. *Positive* (Ramsdens).
2. *Negative* (Huyghenian).
3. *Diagonal.*
4. *Solar* (Dawes).
5. *Terrestrial* or *erecting.*

Eye-piece Mi-crom′e-ter. A graduated slip of glass introduced through slits in the eye-piece tube, so as to occupy the center of the field. Adapted by Jackson.

Eye-rim. A circular single eye-glass, adapted to be held to its place by the contraction of the orbital muscles.

Eye-spec′u-lum. (*Surgical.*) An instrument for dilating the eyelids, to expose the exterior portions of the eye and its adjuncts.

Fig. 1912.



Eye-Speculum.

Eye-splice. (*Nautical.*) A splice made by turning the end of a rope back on itself and splicing the end to the standing part, leaving a loop.

F.

Fab′ric. A cloth made by weaving or felting. The various names are derived from material, texture, fineness, mode of weaving, color, mode of coloring, surface-finishing, place of manufacture, etc.

> "Each glossy cloth, and drape of mantle warm,
> Receives th' impression ; ev'ry airy woof,
> Cheyney, and baize, and serge, and alepine,
> Tammy, and crape, and the long countless list
> Of woolen webs."
>
> DYER, *The Fleece*, 1757.

The following list includes the names of the principal varieties of fabrics, except those of merely fanciful and ephemeral nature : —

Abee.
Aditis.
Aërophane.
Agabanee.
Alpaca.
Anabasses.
Anacosta.
Anagaripola.
Angola.
Arbaccio.
Arlienanse.
Armozine.
Armure.
Atlas.
Baetas.
Baft.
Baftas.
Bagging.
Baize.
Balmoral.
Baluster.
Balzarine.
Bandanna.
Bandannois.
Bangra.
Barège.
Barmillians.
Barracan.
Barrage.
Barras.
Barretees.
Batiste.
Barutine.
Bauge.
Beaver.
Beaverteen.
Bengal.
Bengal-stripes.
Bergamot.
Bezan.
Binding-cloth.
Birrus.
Blancard.
Blanket.
Blunk.
Bobbinet.
Bocasine.
Bocking.
Bombazine.
Bonten.
Book-muslin.
Bootee.
Boquin.
Borders.
Borel.
Boshah.
Braid.
Breluche.
Brilliant.
Broadcloth.
Brocade.
Brocatelle.
Buckram.
Buke-muslin.
Bunting.
Burdett.
Burlap.
Cacharado.
Cadence.
Caffa.
Calamanco.
Calico.
Cambayes.
Cambria.
Camlet.
Camptulicon.
Cannequin.
Cangan.
Cantaloon.
Canton flannel.
Cantoon.
Canvas.
Carpet.
Cashmere.
Cashmerette.
Cassimere.
Cassimerette.
Castor.
Cauthee.
Chainwork.
Challis.
Chambray.
Charkana.
Check.
Check-mak.
Chenille.
China-grass cloth.
Chinchilla.
Chiné.
Chintz.
Chitarah.
Cloth.
Coburg-cloth.
Cog-ware.
Collar-check.
Coothay.
Cordillas.
Corduroy.
Cossas.
Cotillion.
Cottonade.
Crape.
Crape-morette.
Crash.
Crepon.
Crequillas.
Crinoline.
Cristale.
Cut-velvet.
Damask.
Damask-satin.
Damassin.
De bege.
De laine.
Demyostage.
Denim.
Diaper.
Diaphane.
Dimity.
Doeskin.
Doily.
Domestic.
Domett.
Dooriahs.
Dorsel.
Dorsour.
Dowlas.
Drab.
Drabbets.
Drap d'été.
Dreadnaught.
Drill.
Drugget.
Ducape.
Duck.
Duffels.
Duroy.
Duttees.
Elastic-goods.
Empress-cloth.
Farandams.
Felted cloth.
Fearnaught.
Fernandina.
Fingroms.
Flannel.
Floor-cloth.
Foulard.
Foundation-muslin.
Frieze.
Fustian.
Gabarage.
Gala.
Galloon.
Gambroon.
Gauze.
Gaze-a-blutoir.
Gimp.
Gingham.
Gobelins.
Golpathen.
Gorgonelle.
Gossamer.
Grass-cloth.
Grenadine.
Grogram.
Gros.
Gunny.
Hair-cloth.
Holland.
Huckaback.
Hum-hum.
India-rubber cloth.
Ingrain.
Jaconet.
Jamdari.
Janus-cloth.
Japanese silk.
Jean.
Jemmy.
Kalmuck.
Kennets.
Keper.
Kersey.
Kerseymere.
Kompow.
Lace (varieties, see LACE).
Lapping.
Lasting.
Lawn.
Leno.
Levantine.
Linen.
Linsey.
List.
Lockram.
Long-cloth.
Loonghie.
Lustring.
Lutestring.
Mail-net.
Marabout.
Marseilles.
Marsella.
Match-cloth.
Matting.
Medley-cloth.
Melton.
Merino.
Milled cloth.
Millinet.
Mixed fabrics.
Mohair.
Moire.
Moleskin.
Moquette.
Moreen.
Mozambique.
Mull-muslin.
Mungo.
Muslin.
Muslin de laine.
Muslinet.
Nacarat.
Nainsook.
Nankeen.
Narrow-cloth.
Neigelli-cloth.
Net.
Nettle-cloth.
Oil-cloth.
Oiled silk.
Oil-skin.
Organdie.
Organzine.
Orleans-cloth.
Osnaburg.
Pack-cloth

Padesoy.	Shag.
Palampoor.	Shalli.
Panne.	Shalloon.
Paper-muslin.	Sheeting.
Paramatta-cloth.	Shirred goods.
Pennistone.	Shirting.
Percale.	Shoddy.
Petersham.	Shot-silk.
Pile.	Silesia.
Pillow.	Silk.
Pilot-cloth.	Silk-shag.
Pique.	Sof.
Piquée.	Soocey.
Plaid.	Spinel.
Plain-back.	Stripe.
Platilla.	Stuff.
Plonket.	Swansdown.
Plumeta.	Swiss-muslin.
Plush.	Tabaret.
Poldway.	Tabby.
Polemit.	Taffety.
Polimita.	Tambour.
Pongee.	Tammy.
Poplin.	Tape.
Pou-de-soy.	Tapestry.
Poulon.	Tarletan.
Poyal.	Tarpaulin.
Princettas.	Tartan.
Print.	Terry-fabric.
Prunello.	Thibet-cloth.
Puddie.	Thickset.
Punjum.	Ticking.
Purdah.	Tickenbergh.
Rattanas.	Tiffany.
Ratteen.	Tinsel.
Ravens-duck.	Tissue.
Razago.	Tobine.
Ribbon.	Toilenet.
Romal.	Tournay.
Rubber.	Toweling.
Rubber-cloth.	Trellis.
Rug.	Tufted fabric.
Rugging.	Tulle.
Rumswizzle.	Tweed.
Russia-duck.	Twill.
Sacking.	Unions.
Sagathy.	Vadmel.
Sail-cloth.	Velours.
Sarsnet.	Velvet.
Satin.	Velveteen.
Satinet.	Verona-serge.
Satin-jean.	Vessets.
Say.	Vitry.
Sayette.	Wadmal.
Seehand.	Watered goods.
Selvage.	Wincy.
Sendal.	Wire-gauze.
Serge.	Yasmas.
Sergette.	Yergas.

Fa-çade′. (*Architecture.*) The front or face view of a building.

Face. The front, exposed, principal, dressed, or effective surface of an object. The surface from which others are laid off or tried, and by which they are tested as to angle or proportions.

1. (*Horology.*) The dial of watch, clock, compass-card, or counting-register.

2. (*Architecture.*) *a.* The front or broad side of a building. The *façade.* The front of a wall.

b. The surface of a stone exposed on the face of a wall. The sides are *flanks,* the upper and lower surfaces are *beds.*

c. The front of an arch showing the vertical surfaces of the outside row of voussoirs.

3. (*Fortification.*) One of the parts which form a salient angle, projecting towards the *country.* See BASTION.

4. (*Carpentry.*) *a.* The front of a jamb presented towards the room.

b. The sole of a plane.

5. (*Forging.*) *a.* The working portion of a hammer-head.

b. The flat part of an anvil.

6. (*Ordnance.*) The surface of metal at the muzzle of a gun.

7. (*Steam-engineering.*) *a.* The flat part of a slide-valve on which it moves.

b. The flat portion on a cylinder forming a seat for a valve.

8. (*Gearing.*) That part of the acting surface of a cog which projects beyond the pitch line. The portion within that limit is the flank.

9. (*Grinding.*) That portion of a *lap* or wheel which is employed in grinding, be it the edge or the disk.

10. (*Printing.*) The inked surface of a type. The character of the face for size, style, and proportions gives the name to the type. As to proportions, it may be standard, extended, compressed, heavy, light, etc.

11. The edge of a cutting instrument.

Face-ham′mer. One with a flat face, as distinct from one having pointed or edged *peens.*

Face-guard. A mask with windows for the eyes, adapted to the use of persons exposed to great heat, as in glass-houses, forging heavy works, and in the various metallurgic furnace operations.

Also for workmen exposed to flying particles of metal or stone.

Cohn, an oculist of Breslau, made an estimate of the number of workmen in metal who had been injured by flying pieces, and found that among 1,283 workmen, 90 per cent had suffered to some extent; 40 per cent had been under medical treatment; 59 were permanently injured; 21 had lost one eye. He introduced mica spectacles.

Face-joint. That joint of a voussoir which appears on the face of the arch.

Face-piece. (*Shipbuilding.*) A piece of wood wrought on the forepart of the knee of the head.

Face-plan. (*Architectural drawing.*) The principal or front elevation.

Face-plate. (*Turning.*) A plate screwed on to the spindle of a lathe, and affording a means of attaching the work to be turned; or a place of attachment for a pin which comes against the *dog* or *driver* on the work and imparts rotation to the latter.

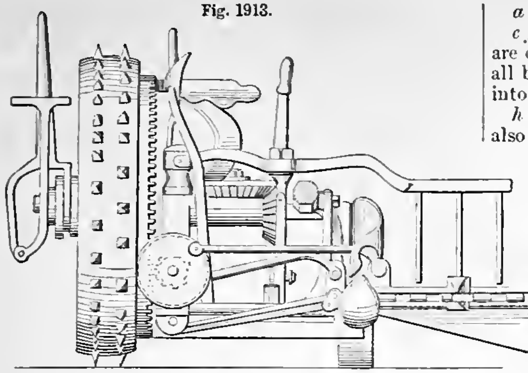
A true plane for testing a dressed surface.

Fac′et. A little face. One of the small planes which form the sides of a natural crystal; of a cut diamond or other gem; of a cut-glass ornament or vessel. The facets of diamonds are known as *skew* or *skill* facets and *star*-facets. *Upper* skill-facets are wrought in the lower part of the *bezel,* and terminate in the *girdle; under* skill-facets are wrought on the *pavilions,* and terminate in the *girdle. Star*-facets are wrought on the bezels and terminate in the table. See BRILLIANT.

Face-wall. (*Building.*) The front wall.

Face-wheel. This is another name for a crown or contrate wheel, which has cogs projecting from the periphery at right angles to the plane of motion. The term is applicable to a wheel whose face rather than its perimeter is made effective, as in the cog-wheels cited and in the annexed illustration, which is the ground-wheel of a harvester. The term is also applied to a wheel whose disk-face is adapted for grinding and polishing. A *lap.*

Fig. 1913.



Face-Wheel.

Fa'ci-a. (*Architecture.*) A flat band projecting slightly from the general surface.

An architrave may have several different faces, termed *facias.*

Fac'ing. An exterior covering or sheathing.

1. (*Hydraulic Engineering.*) *a.* Protection for the exposed faces of sea-walls and embankments. Several different kinds are used, according to the facilities and means.

Earth-work.	Thatch-wood work.
Turfing or sodding.	Wharfing.
Pile and stone work.	Stone-walls.

b. A layer of soil over the *puddle,* upon the sloping sides of a canal.

2. (*Founding.*) Powder applied to the face of a mold which receives the metal.

The object is to give a fine smooth surface to the casting.

The *facing* consists of various materials, economy and the description of casting being taken into consideration.

Meal dust or waste flour.
Powdered chalk.
Ashes of wood or tan.
Charcoal dust.
Loam-stone powder.
Rottenstone powder.

An equivalent effect is produced by depositing a layer of soot upon a metallic pattern by smoking it in a fire of cork shavings, or of resin burned in an iron ladle, or in the flame of a link or a lamp.

3. The front covering of a bank by means of a wall or other structure to enable it to be made steeper than the natural talus of the material.

4. The covering of brick or rough stone-work with fine masonry, such as sawed freestone or marble.

Fac'ing-brick. (*Building.*) Front or pressed brick.

Fag'ot. 1. (*Metal.*) A bundle of scrap or wrought-iron for working over.

It is usually a bunch or pile of bars wedged together in a hoop. If it be large, a round bar in the center is surrounded by the shorter ones and forms a *porter* by which the *fagot* is guided to and from the furnace and underneath the hammer.

Scrap is also *fagoted* for heating in the reverberating furnace, for tilting, or for re-rolling.

In fagoting iron for rolling into beams, respect must be had to the disposition of the pieces, so as to bring the iron of the tread, soffit, and web into the most judicious arrangement for the strain it will be required to bear.

a b c d are fagots for beams.

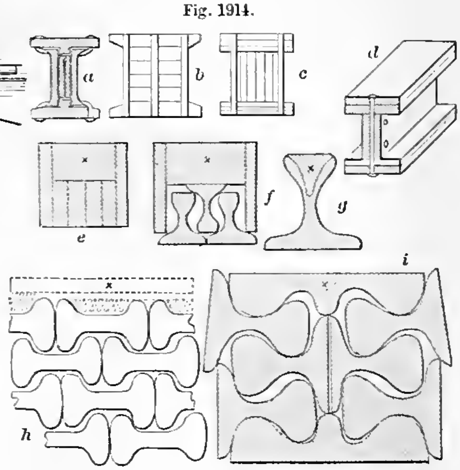
c f are fagots for railway rails in which the portions are of steel, which becomes the tread, as in *g.* *c* is all bar, *f* has a portion of old rails, cut and built into the fagot.

h i are also fagots for beams with steel faces. See also BEAM.

2. A bundle of staves. A *shook.*

3. A bundle of brush-wood. A *fascine.* See also GABION; DIKE; FILLING.

Fig. 1914.

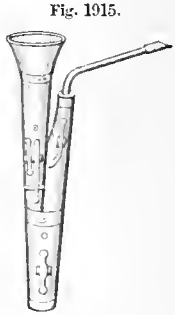


Fagots.

Fag'ot-ed I'ron Fur'nace. (*Metallurgy.*) A form of furnace adapted for scrap and bar cut up and fagoted for reheating and re-rolling.

Fag-ot'to. (*Music.*) An instrument with a reed and mouth-piece like the clarionet, and resembling the bassoon.

Fig. 1915.



Fagotto.

The *alto-fagotto* has a compass of three octaves, commencing with C in the second space, base clef; continuing to the C second ledger line above the treble staff with their intermediate semitones. It has seven keys and key-holes, three on the opposite side to that represented.

Fahr'en-heit. The kind of thermometer used in England and the United States, and named after the inventor. It differs from the Celsius, or centigrade, and the Reaumer. See THERMOMETER.

	Fah.	Centigrade, or Celsius.	Reaumer.
Boiling water .	212°	100°	80°
Freezing . .	32	0	0

Faï'ence. (*Pottery.*) A fine kind of pottery named from Faënza, in Romagna. It was originally made in imitation of majolica, and afterwards acquired some characteristics. Delft afterwards became celebrated for the manufacture of faïence. This ware, having passed through the fire, preserves a certain amount of porosity, and is then covered with a glaze.

The different kinds of faïence are produced by the use of common or of fire clay; the admixture of sand with the clay, as in Persian ware; the use of a transparent or of a colored glaze; of an opaque or translucent enamel ; and by a combination of these processes on the same piece.

Faints. (*Distilling.*) The later results of distillation of *wash*, of low specific gravity, and reserved for redistillation.

Fair-lead'er. A guide for a rope. It may be a thimble, cringle, or sheave.

Fig. 1916.

Fair-Leader.

A perforated board, through whose respective holes the various ropes of running-rigging are rove to keep them distinct.

Fair-leath'er. (*Leather-manufacture.*) Leather finished in the natural color or that imparted by the tanning process ; free from any special coloring, — black, for instance.

Fake. A winding or coil of a rope or hawser. In the *coil* the *fakes* are a helix, and a range or layer of *fakes* forms a *tier*. When the rope is arranged to run free when let go, as in rocket-lines, it is disposed in parallel bends of one fathom each.

Fal'chion. (*Weapon.*) A sword in use in the 13th century, with a broad blade widening towards the point, the edge convex.

Fal'con. An old-time piece of ordnance, about 7 feet long, having a bore of 3 inches, and throwing a 3-pound ball.

Fal'co-net. An old piece of ordnance, smaller than a falcon, throwing a ball of $1\frac{1}{2}$ pounds weight.

Fald-stool. A folding stool, or backless seat. It is as old as Rameses, and is now commonly called a *camp-stool*. *Faldistory.*

Fall. 1. That part of the rope in hoisting-tackle to which power is applied. One end of the rope is attached to a point of support, say a hook or an eye below the upper block of the tackle, and is then rove through the blocks ; the end carried to the *winch, capstan, crab*, or other hoisting-engine, is the *fall*.

2. The amount of descent in a given distance ; as, —

a. The vertical pitch of water at a mill.

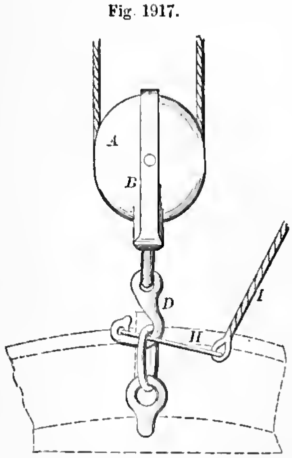
b. The inclination of a water-course.

Large and deep rivers run swiftly with a fall of 1 foot per mile, or 1 in 5,000.

Smaller rivers and branches require double the fall, or 2 feet per mile, 1 in 2,500.

Small brooks hardly keep an open course under 4 feet per mile, or 1 in 1,200.

Fig. 1917.



Davit-Fall-Block Hook.

Ditches and covered drains require 8 feet per mile, or 1 in 600.

Furrows of ridges and open drains require a still greater fall.

Fall and Tack'le. The fall is the pulling-end of the rope ; the tackle is the blocks with the rope rove through them. See BLOCK ; TACKLE ; PURCHASE.

Fall-block Hook. A hook *D* for a davit-fall block *A B* released by the action of the cord *I* and link *H*, when the boat has descended a certain distance, the end of the rope *I* being secured on deck. There are other forms. See DAVIT.

Fall'er. 1. (*Cotton-manufacture.*) The *faller* is an arm on a *mule-carriage*, operating the *faller-wire*, whose duty it is to depress the yarns when the carriage is about to run back, in order that the yarns may begin to wind on at the bottom of the *cop* and be regularly distributed thereon as the faller-wire is raised. See MULE. The *counterfaller* is another wire beneath the yarns, and counter-weighted to keep them taut.

2. (*Flax-manufacture.*) A bar in the flax-spreading machine, having attached a number of vertical needles, forming a comb or *gills*. A *gill-bar*. The office of the *gills* is to simulate the action of the human fingers in detaining to some extent the *line* as it passes to the drawing-roller. See SPREADER.

The term *faller* is derived from the motion, the *gill* being raised and lowered so as to alternately detain and release the *line*.

Fall'er-wire. 1. A horizontal bar by which the rovings, slubbings, or yarn are depressed below the points of the inclined spindles in a *slubbing-machine* or *mule*, in order that they may be wound into *cops* upon the spindle in the backward motion of the *billy*, or *mule*-carriage, as the case may be. See SLUBBING-MACHINE ; MULE.

2. A device in the silk-doubling machine for stopping the motion of the bobbin if the thread break. The wire is hung by its eyelet end to the thread, and with the breakage of the latter falls upon the lighter arms of a balance-lever and actuates a detent.

False. A term used as to constructions, or parts of a temporary or supplemental character.

False-core. (*Founding.*) A part of a pattern which is used in the *undercut* part of a mold, and is not withdrawn with the main part of the pattern, but removed by a lateral draft subsequently.

False-keel. (*Shipbuilding.*) Timbers worked on to the main or true keel, and intended, —

1. To prevent leeway.
2. To protect the main keel in case of grounding.

False-keel'son. (*Shipbuilding.*) One lying longitudinally above the real one.

False-key. A key roughly made of a bent slip adapted to avoid the wards of a lock. A *pick-lock*.

False-pile. (*Pile-driving.*) An additional length given to a pile after driving. A temporary prolongation at the upper end, when the pile has passed beyond the immediate reach of the monkey, is called a *sett*.

False-rail. 1. (*Carpentry.*) A thin piece of timber inside of a curved head-rail.

2. (*Shipbuilding.*) A facing or strengthening rail fayed to a main rail.

False-roof. (*Carpentry.*) The part between the ceiling of the upper chambers and the roof-covering.

False-stem. (*Shipbuilding.*) One fayed to the forward part of the stem.

False-stern. (*Shipbuilding.*) *False stern-post*, etc. Supplemental structures or timbers accessory to the main parts or pieces.

False-works. (*Civil Engineering.*) Construction works to enable the erection of the main works. Among *false-works* may be cited coffer-dams, bridge-centering, scaffolding, etc.

Fan. 1. A device waved or rotated to cause a circulation of air.

The *chowry*, or fly-flapper of the plains of India, is made of the bushy tail of the Thibetan yak.

Fans made of ostrich and other feathers were commonly used in Egypt, for the purpose of setting the air in motion, and also for brushing away flies. The honor of attending the king in the capacity of fan-bearer was conferred upon his sons, and we see them in many Egyptian paintings and sculptures, with the insignia of princes and carrying the flabella, a wing or bunch of feathers on the end of a long handle. Among other paintings may be specially cited that of the triumph of Rameses III., the great Sesostris of Herodotus, about 1355 B. C. The flabellum is shown in the tombs of Beni-Hassan, Thebes, and Alabastron, of dates from 1706 to 1355 B. C. In more humble life, men are represented keeping the flies away from the drink prepared for the reapers in the field. See BELLOWS; BLOWER; PUNKAH; VENTILATOR; and list under AIR-APPLIANCES.

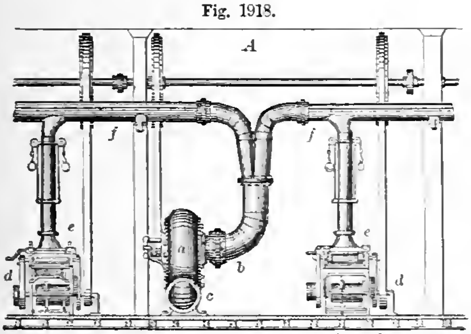
"Cape hoc flabellum, et ventulum huic sic facito," — Take this fan, and give her thus a little air.

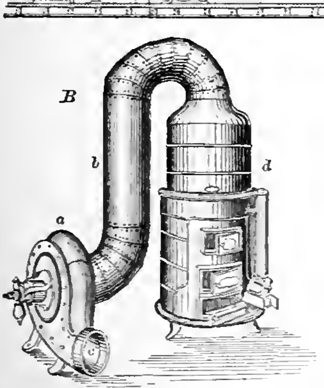
Fans made of ostrich and other feathers maintained their hold upon the people, and were common in the reign of Elizabeth, being ornamented with gold and silver. According to Evelyn, our modern paper fans were introduced by the Jesuits from China.

The common palm-leaf fan of this country is imported from the East and West Indies, and is made of a portion of the leaf and stalk; the leaf being bound on the edges with strips and thread. The Japanese fan is made of bamboo and paper. A stalk of bamboo forms the handle, is split into a number of fibers which are displayed in fan shape and fastened in position while paper is applied on each side. They are then painted and inscribed with scenes rural and humorous, and have mottoes which do not convey any very distinct impression to us as a people.

Mechanical fans for household uses are driven by clock-work or weight, are rotary or oscillating. On a larger scale, they are used for urging fires and

Fig. 1918.





Fan-Blowers.

for ventilation (see BLOWER), and for purposes of cleaning grain. See FANNING-MILL.

2. The small vane which turns the cap of the smock-mill on its axis, to keep the sails presented to the wind.

Fan-blow'er. A blower in which a series of vanes fixed on a rotating shaft creates a blast of air for forge purposes, or a current for draft or ventilation. In the example (*A*, Fig. 1918), the machine is applied to removing shavings from the cutters of planing-machines. The rotation of the fan, by belt and pulley, in its box *a*, causes a downward draft through the pipe *b*, connected with which are the horizontal pipes *f f* and vertically adjustable pipes *c c*, having flaring mouths directly over the cutters *d* of the planers; the shavings are drawn upward through the pipes *e*, and carried through *f b*, when, passing through the blower, they are driven through its mouth *c* into a chute which takes them to an apartment whence they may be removed as required for fuel.

B (Fig. 1918) is intended for intensifying the draft of a furnace *d*; the products of combustion, being caused to take first an ascending and then a descending course through the curved pipe *b*, are expelled at *c*. Blowers are *plenum* (pressure), or *vacuum*, which is equivalent to exhaust; either form is used for the various purposes of ventilation, air-draft for furnaces, etc. See also BLOWER; FANNING-MILL.

Fan'cy-line. (*Nautical.*) A down-haul line passing through a block at the jaws of a gaff.

Fan'cy-roll'er. (*Carding-machine.*) One placed immediately in advance of the *doffer*, and provided usually with straight wire teeth, its function being to loosen up the wool on the main cylinder so that it may be taken up with facility by the *doffer*.

Fan'don. A large copper vessel in which the "hot process" of amalgamation is conducted, blocks of copper being drawn around like the porphyry blocks in an arrastra.

Fane. A weathercock. A *vane*.

Fang. 1. (*Mining.*) *a.* A niche cut in the side of an adit or shaft to serve as an air-course.

b. An air-pipe of wood in a shaft. An air-main.

2. A projecting tooth or prong in a lock, bolt, or tumbler.

3. (*Nautical.*) *a.* The valve of a pump-box.

b. The bend of a rope.

4. A long nail.

5. A projecting claw, as that on the reverse of a belt plate, which passes through the belt and is clenched or riveted at the rear.

6. The tang of a tool.

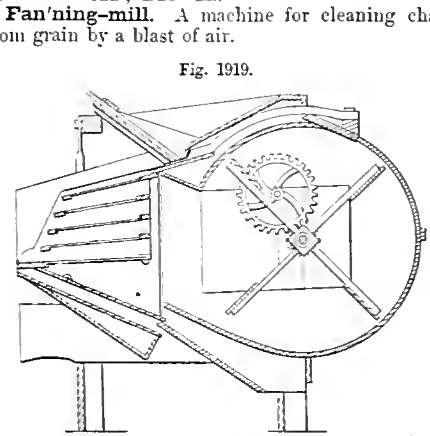
Fan'ion. (Ital. *gonfalone*, a standard.) A small flag for a surveying-station.

Fan-light. (*Architecture.*) A semicircular transom window.

Fan'ner. A blower or ventilating-fan. See FANNING-MILL; BLOWER.

Fan'ning-mill. A machine for cleaning chaff from grain by a blast of air.

Fig. 1919.



Fanning-Mill.

The fans mentioned in the Bible were used for winnowing or cleaning grain. A floor of beaten earth was prepared in a situation exposed to the wind, and the grain and chaff were thrown up by a shovel. The fan was for raising an artificial blast, and was evidently a hand implement. "His fan is in his hand" (Matt. iii. 12). Winnowed with the shovel and the fan (Isaiah xxx. 24). The machine in its simplest form is a rotary shaft with flapping breadths of canvas suspended from the arms.

Fig. 1919 represents the ordinary fanning-mill, having rotating arms with vanes to produce blast, a hopper for the grain, and a series of sieves of varying fineness for sorting the grain into qualities and keeping it longer exposed to the blast. The fanning-mill forms part of the THRASHER and SEPARATOR (which see) and of the clover-huller. Sir Walter Scott relates, in one of his novels, that the religious feeling of some of his countrymen was greatly shocked at an invention by which artificial whirlwinds were produced in calm weather, when it was the will of God for the air to remain still. As they considered it a moral duty to wait patiently for a natural wind to separate the chaff from their wheat, they looked upon the use of the machine as rebellion against God.

Fan'ning-out. Spreading out the sheets of a pile of paper by grasping a corner and giving a dexterous twist. It is to facilitate counting.

Fan Steam-en'gine. The action of this steam is the inverse of that of the fan. The outer annular casing receives steam from the boiler and discharges from its inner surface in tangential jets upon the scoop-shaped blades which are attached to a rotating shaft.

It is one form of the rotary steam-engine, and may be compared to the inward-flow turbine.

The outward-flow turbine has also its congener in a form of rotary steam-engine, in which the steam passes through a central pipe and out at the periphery, impinging by direct pressure upon the curved buckets.

Numerous are the resemblances between this type of rotary steam-engines and the reaction water-wheels or turbines. The constructive features of the Æolipile of Hero and the Barker water-wheel are identical, and the family features are still visible in the rotary steam-engines, rotary-pumps, and water-wheels. This is not extraordinary, when it is considered that the impact or direct pressure of a fluid is in each case exerted upon a body which, by its construction and relation, is confined to move in a curved path, conferring a rotary motion upon the axle to which it is attached.

Fan-tail. 1. A form of gas-burner in which the burning jet has an arched form.

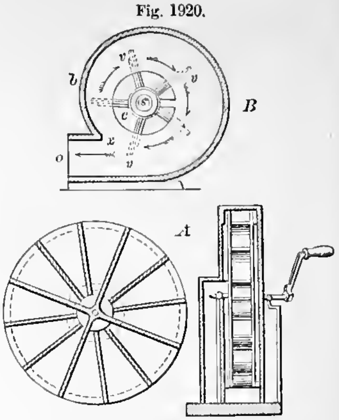
2. A kind of joint.

Fan-vault'ing. (*Architecture.*) A form of arching in which the ribs of the arch diverge from the impost like the sticks of a fan.

Fan-ven'ti-la'tor. The oldest known form of this device is the corps of worker bees arranged on each side of the entrance hole, a little within the hive, engaged in incessantly vibrating their wings so as to cause a circulation of air into, through, and out of the hive. An ingoing and outgoing current is established at the hole, as has been proved by holding filaments of cotton at the aperture.

The *fan* as a mechanical ventilator appears to have been invented by Dr. Desagulier, 1734. His fan (*A*, Fig. 1920) was a wheel 7 feet in diameter, 1 foot wide, and had 12 vanes which approached within 12 inches of the axis, around which was an opening 18 inches in diameter. The vanes rotated as near as possible to the case, which was lined with blanket as a packing. The case was concentric, and had an eduction and an eduction pipe, the one axial, the other peripheral.

Fig. 1920.



Eccentric Fan.

Such a wheel was used above the ceiling of the British House of Commons from 1736 to 1817.

Dr. Desagulier's fan was concentric with its case, but an improvement was to make it eccentric.

Fairbairn and Lillie's eccentric fan is shown at *B*; *s* is the shaft, *b* the case, *v* the vanes, *c* the eduction opening, *o* the discharge. The point *x* is a shoulder which acts as a cut-off in connection with each passing vane, and confines the stream of condensed air to the eduction passage. See also VENTILATOR.

Fan-wheel. This usually consists of an armed shaft with wings or beaters, and revolves in a case. It is used in grain-cleaners, winnowing-machines, blowers for furnaces, etc., and is the most common device for obtaining a blast of air for any purpose. The air is drawn in at the central opening and discharged at the tangential chute. Where great force is required positive devices are used, partaking of the nature of pumps. The volute-wheel is also used for a similar purpose. See FANNING-MILL; BLOWER; BLOWING-APPARATUS.

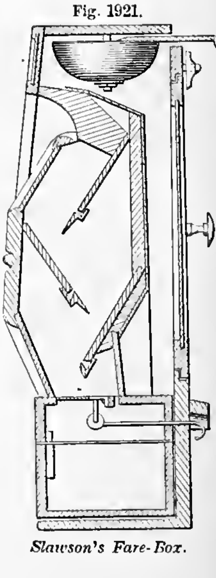
Fan-win'dow. (*Architecture.*) A semicircular window with radial sash.

Far'an-dams. (*Fabric.*) A mixed fabric of silk and wool.

Far'cost. A Scotch trading-vessel.

Fare-box. A place of deposit for fares in street-cars. It has a receiving aperture, windows at which the money or ticket may be seen by the passenger inside and the driver outside the car; a series of slanting plates, which allow the money to drop, but prevent its abstraction; a plate on which the fare falls, and which is tilted to discharge it into a locked box beneath.

Fig. 1921.



Slawson's Fare-Box.

Fas'cet. (*Glass.*) An iron-wire basket on the end of a rod, to carry the bottle from the blowing-rod or the mold to the *lcer.*

A rod inserted into the mouth of the bottle for the same purpose is also called a *fascet.*

Fas'ci-a. A flat architectural member in an entablature. A broad fillet.

The architraves of some orders are divided into *fascias.*

Fas-cine′. A cylindrical bundle or fagot of brush-wood used in revetments of earthworks. They vary in size, say from 6 to 18 feet in length, 6 to 9 inches in diameter, and are bound with withes every 18 inches. When the limbs are stouter and longer than usual, it is called a *saucisse* or *saucisson*.

A *gabion* is a basket for earth; not a bundle of brush.

In civil engineering, *fascines* and *gabions* are used in making sea and river walls to protect shores subject to washing; or to collect sand, silt, and mud to raise the bottom and gradually form an island, either as a breakwater or for cultivation, as in Holland.

Fash′ion-ing-nee-dle. (*Knitting-machine.*) One of the pins or fingers employed to take loops from certain of the bearded needles and transfer them to others for widening or narrowing the work.

Fash′ion-piece. (*Shipbuilding.*) One of the pair of cant frames which form the exterior angle of the stern-framing; between them extends the *wing-transom*, which is the base-piece of the *counter-timbers*.

Fast. (*Nautical.*) A mooring rope or hawser, securing a vessel, and named from its position; as, *head, bow, breast, quarter*, or *stern* fasts, as the case may be.

Fast-and-loose Pul′leys. (*Machinery.*) A device for disengaging and re-engaging machinery. One pulley is fast to the shaft, the other runs loosely thereupon. The band is turned on to either, as the work requires.

Fas-tig′i-um. 1. The pediment of a portico.

2. The comb or ridge of a roof.

Fast-pul′ley. (*Machinery.*) One keyed to the shaft so as to revolve therewith. In contradistinction to the *loose-pulley*, which is *loose* on the shaft, and to which the belt is transferred when the rotation of the shaft is no longer desired.

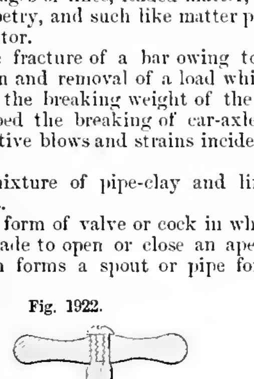
Fat. (*Printing.*) Copy which affords light work, as blank or short pages or lines, leaded matter, rule-and-figure work, poetry, and such like matter profitable to the compositor.

Fa-tigue′. The fracture of a bar owing to the repeated application and removal of a load which is considerably below the breaking weight of the bar. To *fatigue* is ascribed the breaking of car-axles by the constant repetitive blows and strains incident to their duty.

Fat-lute. A mixture of pipe-clay and linseed oil for filling joints.

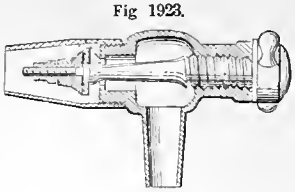
Fau′cet. 1. A form of valve or cock in which a spigot or plug is made to open or close an aperture in a portion which forms a spout or pipe for the discharge or passage of a fluid. The ordinary beer-cock is well known. Fig. 1922 shows a less usual form, in which the central aperture is closed by an elastic packing at the foot of a screw-plug, and opened by the raising of the latter. Fig. 1923 is a modified form having some similar features.

Fig. 1922.



Screw-Plug Faucet

Fig 1923.



Faucet.

2. The enlarged end of a pipe to receive the spigot-end of the next section.

See under the following heads:—

Auger-faucet.	Gage-faucet.
Ball-cock.	Grease-faucet.
Basin-faucet.	Hot-water faucet.
Beer-faucet.	Measuring-faucet.
Bib.	Molasses-gate faucet.
Blow-off cock.	Pet-cock.
Boring-faucet.	Pit-cock.
Bottle-faucet.	Robinet.
Cork-faucet.	Rotary valve.
Diaphragm-faucet.	Spring-faucet.
Filter-faucet.	Stop-cock.
Four-way cock.	Three-way cock.

Fau′cet-bit. A cutting lip and router on the end of a faucet. The faucet is rotated to cut the hole in the head of the cask, and then the barrel of the faucet immediately occupies the aperture so made. A *boring-faucet*.

Fau′cet-fil′ter. One having a chamber for filtering-material.

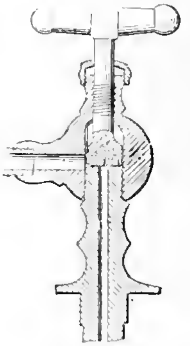
Fau′cet-joint. 1. An expansion-joint for uniting two parts of a straight metallic pipe, which is exposed to great variations of temperature.

2. One form of breech-loader in which the rear of the bore is exposed by the turning of a perforated plug. See FIRE-ARM; *Class B, Div.* 5.

Fau′cet-key. One fitting upon a concealed square projection on the plug of a faucet.

Fau′cet-valve. One in which the puppet or plug-valve is operated by a handle of the faucet order.

Fig. 1924.



Faucet-Valve.

Fauld. The *tymp-arch* or working arch of a furnace.

Fault. (*Mining Engineering.*) The dislocation of a stratum or seam by which the continuity is destroyed and one portion becomes relatively lower than the other. Known also as *shift, slip*.

Fausse′braye. (*Fortification.*) A low rampart or counter-guard to protect the lower part of the main escarp.

Fau-teuil′. An easy, upholstered arm-chair.

Fay. A shipwright's term for fitting one piece of timber or plank to another.

Joining two pieces so as to make a flush surface.

Fay′ing-sur′face. That surface of a plate or angle-iron which is to be against the object to which it is to be riveted. The *faying-surface* of the *side-arm* of the angle-iron of a ship's side, and the inside or *faying-surface* of the plate, are in contact.

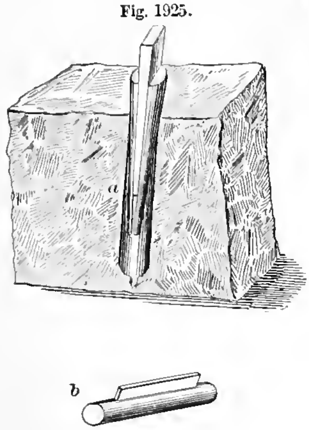
Fear′naught. (*Fabric.*) A heavy, shaggy, woolen fabric, used for seamen's coats, for lining port-holes and the doors of powder-magazines. *Dreadnaught*.

Feath'er. 1. A slip (*b*) inserted longitudinally into a shaft or arbor, and projecting as a fin therefrom so as to fit a groove in the eye of a wheel which may have a longitudinal motion on the said shaft, but no rotation. A *spline*.

2. A wedge-shaped key between two semi-cylindrical plugs (*a*) placed in a bored hole in a stone, and driven in to rend the stone.

3. A tongue on the edge of a board.

Fig. 1925.



Feathers.

4. The angular adjustment of a propeller blade or of an oar in rising from the water.

5. A narrow strengthening strip on a structure. A longitudinal rib on a shafting to resist flexion or fracture.

6. The plumage of birds, as well as the tail and wing feathers, are used for certain purposes after undergoing cleansing and bleaching processes.

Ostrich feathers are procured from Africa, those plucked from live or recently killed birds being the best.

The feathers are tied together in bundles; rubbed in tepid water and soap to free them from grease; washed in pure hot water; dipped in a heated solution of Spanish white; washed; steeped in water tinted with indigo, to correct the yellow color; sulphured; dried.

The ribs are rubbed to render them pliant, and the vanes curled by pressure with a blunt knife.

They are dyed rose-color by safflower and lemon-juice; red by Brazil wood followed by cudbear; blue by indigo; yellow by turmeric; alum is the usual mordant.

The beautiful aniline colors are fast superseding the others for superior work.

Feath'er-edged. Said of boards. One edge is thinner than the other. Used for weather-boarding.

Feath'er-edge File. A file with an acute edge; the cross-section of the file being an isosceles triangle with a short base. A *knife*-file.

Feath'er-ing-float. The paddle or float-board of a paddle-wheel, so arranged as to turn on an axis to present its broad side to the water at its lowest submergence, but to turn its edge to the water in entering and emerging.

Feath'er-ing Pad'dle-wheel. A wheel whose floats have a motion on an axis, so as to descend nearly vertically into the water and ascend the same way, avoiding beating on the water in the descent and lifting water in the ascent. The loss of power from these causes is not as great as is commonly supposed. Some floats are made to feather on axes parallel to that of the wheel, others on axes radial thereto. There are numerous plans.

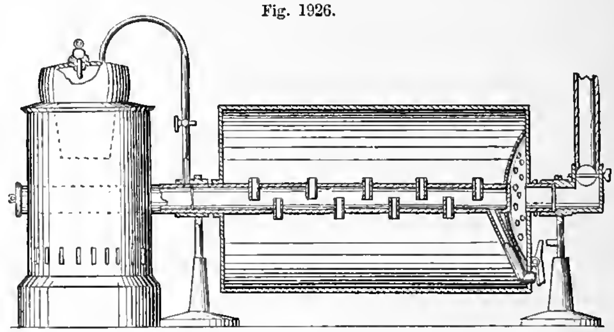
Feath'er-ing-pro-pel'ler. An invention of Maudslay, London, in which the vanes of the propeller-screw are adjustable, so as even to be turned into the plane of the propeller-shaft and offer no resistance when the vessel is under sail and the propeller not used.

Feath'er-ing-screw. See FEATHERING-PROPELLER.

Feath'er-joint. A mode of joining the edges of boards by a fin or feather let into opposite mortises on the edges of the boards.

Feath'er-ren'o-va'tor. A machine in which

Fig. 1926.



Feather-Renovator.

old feathers may be scalded, purified, and dried, so as to remove effete matter from them. One example among many may be given. Warm or cold air is forced from a chimney through conducting passages in such connection with a boiler and steam-pipes that the air may be moistened more or less with steam as required. Hollow bearings for the renovating cylinder serve as couplings between the central pipe and the draft pipe.

Feath'er-spring. (*Gun-making.*) The *sear-spring* of a gun-lock.

Feed. 1. The motion or action which carries stuff forward to the machine; as, —

The cloth to the needle in a sewing-machine.

The board to the planer, etc.

2. The motion of a tool towards its work; as, —

The auger, bit, or drill into the object.

The cutter on the slide-rest of a lathe to or parallel to the work suspended on the centers, etc.

3. The supply of material to a machine; as, —

The water to a steam-boiler.

The grain to a run of stones.

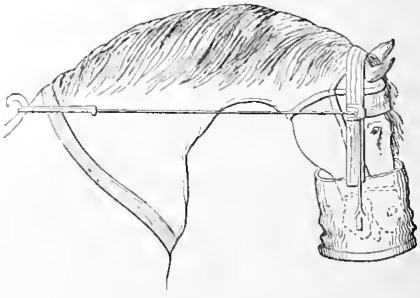
Blanks to a coining-press, or punching-machine.

Eyelets or planchets to the appropriate machines.

Wool or cotton to a carding-machine, etc.

Feed-bag. A nose-bag for a horse or mule, to contain his noon-day feed or luncheon.

Fig. 1927.



Feed-Bag.

Feed-cloth. (*Fiber.*) The apron which leads the cotton, wool, or other fiber into the cleaning, lapping, carding, spinning, or other machine.

Feed-cut'ter. A machine for cutting straw, hay, or cornstalks into short feed or chaff. See STRAW-CUTTER.

Feed'er. An auxiliary or a supplying part of a machine, that which leads along the stuff being operated upon.

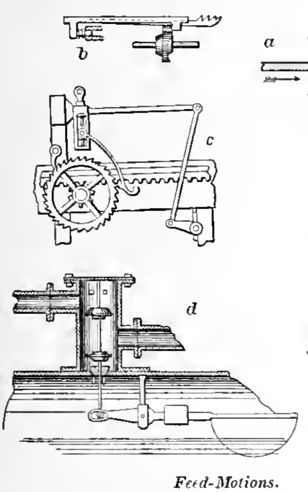
1. (*Hydraulic Engineering.*) A water-course, natural or artificial, carrying water to a canal or reservoir. Obviously, the principal feeder is at the summit level, and it is commonly supplied from a reservoir.

2. (*Mining.*) The side branch of a vein which passes into a lode.

3. (*Sewing-machine.*) That part (*b*, Fig. 1928) which carries the cloth along the length of a stitch between each penetration of the needle. See SEWING-MACHINE FEED. The illustration shows the Wilson four-motion feed.

4. (*Machinery.*) *a.* A toothed or binding wheel which carries the plank into the planing-machine (*a*, Fig. 1928); or a feed for gate-saws (*c*, Fig.

Fig. 1928.



Feed-Motions.

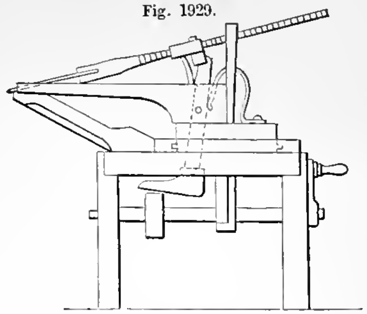
1928), in which a reciprocating arm is provided with a dog to engage the rim of a wheel on the axis of the roller beneath the log-carriage, and so advance the log to the saw a graduated amount at each rise of the saw-gate. An apron of a blowing, cotton-cleaning, lapping, or carding-machine, etc.

b. That motion or combination of parts which carries and directs a blank or rod to the place where it is operated upon. Such are the feeders and feed-motions in machines for making wood screws, pins, eyelets, hooks and eyes, etc. Such also are the motions by which planchets are fed to the coining-press; eyelets and clasps to the machines for attaching them to garments; pins, needles, and hooks and eyes to the machines which stick and paper them.

5. The nail-plate feeder has an intermittent oscillating or semi-rotary and forward motion to present the plate to the cutters so that the head of the nail may be taken from the respective edges alternately.

6. The grain-feeder which forwards the opened sheaves into the throat of the thrasher; or the grain into the eye of the millstone; or the grain and

Fig. 1929.

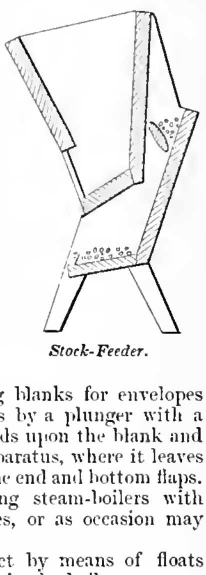


Nail-Plate Feeder.

chaff from the hopper to the riddle of a winnowing-machine; or the grain from the bin to the manger of sheep or other stock. See Fig. 1930.

7. (*Printing, etc.*) A device with fingers which take the top sheet from a pile and lead it into the press where it is printed, folded, or what not. Also a device by which blanks are taken successively from a pile and carried into an envelope-machine, or paper-bag or box machine, as the case may be.

Fig. 1930.



Stock-Feeder.

Some printing-presses and envelope-machines have an aspirator or pneumatic contrivance by which the upper sheet of the pile is picked off and led into the machine. Comly's patent, 1853. See also ENVELOPE-MACHINE. See "Ringwalt's Dictionary of Printing," Philadelphia, 1871, pp. 224, 225.

The usual mode of feeding blanks for envelopes from the pile to the folders is by a plunger with a gummed surface; this descends upon the blank and moves away to the folding-apparatus, where it leaves the blank ready gummed on the end and bottom flaps.

8. A device for supplying steam-boilers with water in graduated quantities, or as occasion may require.

Automatic boiler-feeders act by means of floats upon the surface of the water in the boilers.

One of the illustrations (*d*, Fig. 1928) shows a floating ball on a lever to whose other end is a valve-rod which is lifted when the ball descends below its normal height; floating on the water at the proper level.

The other form (*e*, Fig. 1928) is only intended for supplying water from cisterns at a considerable elevation.

Feed-hand. (*Gearing.*) A rod by which intermittent rotation is imparted to a ratchet-wheel.

Feed-head. 1. (*Steam.*) A cistern containing water and communicating with the boiler of a steam-engine by a pipe, to supply the boiler by the gravity of the water, the hight being made sufficient to overcome the pressure within the boiler.

2. (*Founding.*) Also called *dead-head*, or simply *head*. The metal above and exterior to the mold which flows into the latter as the casting contracts, and also serves to render the casting more compact by its pressure. Also called a *riser*, and the metal which occupies it a *sullage-piece*.

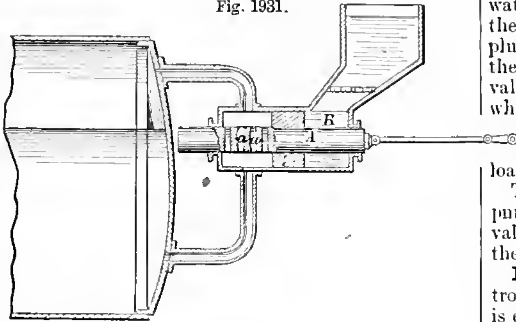
Feed-heat'er. 1. A drum or chamber in which feed-water for the boiler is heated by the exhaust steam.

2. A boiler or kettle for heating food for stock.

Feed'ing-en'gine. (*Steam.*) A supplementary engine for *feeding* the boiler, when the main engine is stopped. A *doctor.*

Feed'ing-head. (*Founding.*) An opening in a mold up which the metal rises, and which supplies metal as the casting contracts

Fig. 1931.



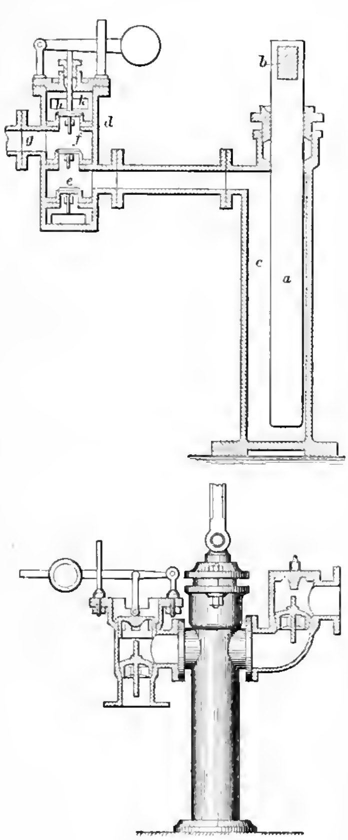
Boiler-Feeder.

Feed-mo'tion. That contrivance in a machine by which the material under treatment is advanced. See FEED.

Feed-pipe. (*Steam-engine.*) The pipe carrying water to the boiler. See FEED.

Feed-pump. A force-pump driven by hand, by doctor-engine, or by the engine itself, for supplying to the boiler a quantity of water equal to that removed in the form of steam, by the brine-pump, the blow-off or mud valve, or other sources of outlet.

Fig. 1932.



Feed-Pump of Marine Engine.

In high-pressure engines it takes water from the heater; in condensing engines from the hot-well.

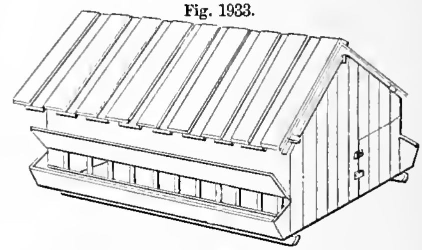
In locomotives it usually takes the form of the Giffard injector. (See INJECTOR.) In the example (Fig. 1931) a plug *A* with cross cells *a a* is constantly reciprocated and carries water from *B* at each passage, when the level in the boiler falls below the top of the plunger.

The *feed-pump* of a marine engine has a plunger *a* attached to the cross-head *b* of the air-pump, and working through a stuffing-box in the pump-barrel *c*. *d* is the valve-box attached to the side of the hot-well; *e* is the suction-valve through which the water is drawn from the hot-well into the pump by the rise of the plunger. At the descent of the plunger the water is driven out at the valve *f* along the feed-pipe *g* to the boiler, unless the regulating valves or cocks to the boiler should be quite closed, when it raises the loaded valve *h* and returns to the hot-well by the aperture *k*. The load per square inch on the valve *h* must somewhat exceed the load per square inch of the steam in the boiler.

The lower portion of Fig. 1932 shows the feed-pump of the Cornish-engine, which has also a safety-valve, so that no injury may arise by shutting off the feed when the pump is at work.

Feed-rack. A stock-feeding device with grain-trough and hay-rack under shelter, which sometimes is extended to the stock also. In the example, the sheep are intended to be inside, and the hay introduced into the racks from the outside. The shed is made in sections to admit of removal on a wagon, and is placed on runners for movement in the field. The feed-troughs are opened on the outside for the introduction of hay, which is accessible through racks on the inside.

Fig. 1933.



Sheep Rack and Shelter.

Feed-screw. (*Lathe.*) A long screw employed to impart a regular motion to a tool-*rest* or to the work; as the feed-screw in the bed of a lathe, which moves the screw-cutting tool.

Feed-wa'ter Ap'pa-ra'tus. An automatic device for supplying steam-boilers with feed-water. Of the very large number of devices for this purpose, many agree in one particular. A vertical pipe leading from a reservoir of water enters the top of the boiler, and its lower open end is at the lowest allowable level. In its normal condition the pipe is full of water, but when the level of the water falls below the level of the open foot of the pipe, steam enters the latter and water flows out till the foot of the pipe is again immersed. In some cases the steam is made to give an alarm at this point of depression of the water-level. See LOW-WATER ALARM.

Other forms of apparatus have valves operated by floats. See BOILER-FEEDER; FEED-PUMP, etc.

A form of feed-water apparatus by which water is taken on board the tender while the locomotive and train are in motion is adopted on some railways in the United States and in England. On the Hudson River Railway, for instance, at Melrose, is placed between the rails of the track a trough 1,200 feet long, 18 inches wide, 15 inches deep, and holding 16,000 gallons of water. The tender has a pipe with a nozzle pointing forward, and capable of being raised and lowered. The train running at full speed, the nozzle is let down so as to pass two inches below the surface of water in the trough, and the water is thereby forced through the nozzle into the pipe and thence to the tender.

The plan was invented and patented by Angus McDonald of Virginia, 1854, but was first introduced in England.

Feed-wa'ter Heat'er. A device for heating the feed-water for high-pressure engines by passing it through a chamber traversed by a coil of pipe carrying the exhaust steam.

Feed-wa'ter Pump. See FEED-PUMP.

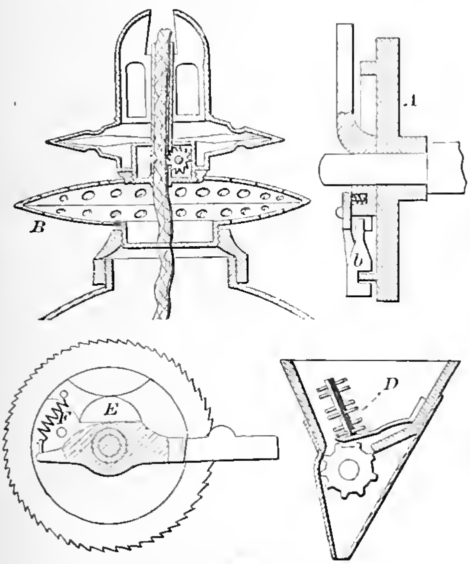
Feed-wheel. A continuously or intermittingly revolving wheel or disk which carries forward an object or material, as in the examples, where

B represents the feed-wheel as applied to a lamp-wick.

A, a binding feed by a slotted pawl on a flange of the wheel: this is similar to the cramp-feed, common in one form of saw-mill.

E is one form of sewing-machine feed. The lever being reciprocated at one movement, it clamps the

Fig. 1934.



Feed-Wheels.

block against the wheel and turns it, and on its return motion allows the block to slip in its seat in the inner periphery of the wheel.

D is a feed-wheel to regulate rate of passage of the seed from the hopper of a seeding-machine.

Fell. 1. (*Metallurgy.*) The finer portions of lead ore which fall through the meshes of the sieve when the ore is sorted by sifting.

2. (*Weaving.*) The end of a web, formed by the last thread of the weft.

3. The skin of a beast with the wool or hair on.

4. (*Sewing.*) A form of hem in which one edge is folded over the other and sewed down; or in which one edge is left projecting and is sewed down over the previous seam.

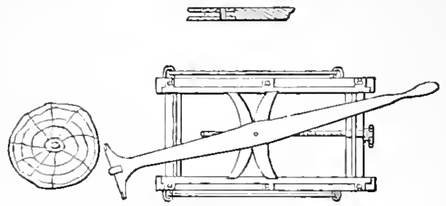
5. To cut down trees.

Fell'er. (*Sewing-machine.*) An attachment for making a felled seam, i. e. one in which two edges being run together are folded over and stitched.

Fell'ing-axe. One specifically adapted for *cutting down* timber, in contradistinction to an axe for *logging off*, *butting*, *lopping*, *hewing*, etc. See AXE.

Fell'ing-ma-chine'. One for cutting down standing timber. In the example, the vibrating

Fig. 1935.



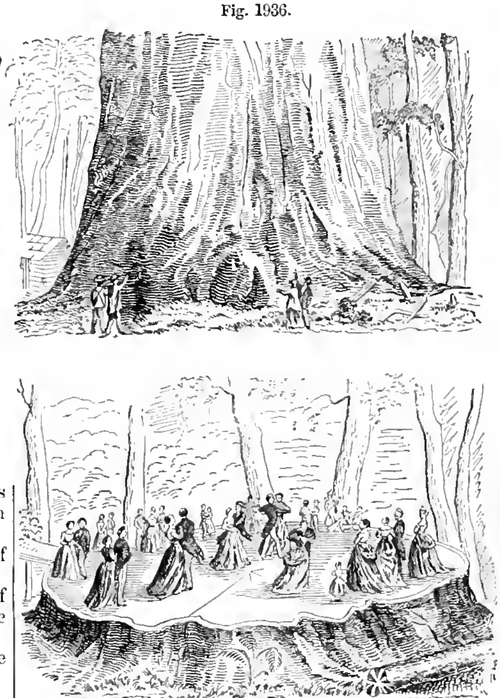
Felling-Machine.

head has chisel and spur cutters, which are made to cut into the tree by the oscillation of the lever and the feed-movement of the carriage.

Other forms of machines for this purpose have gangs of augers, saws which cut kerfs from both sides simultaneously, and so on. It would appear that the contrivers have dropped but few trees, or that they have profited but little by their experience.

Not content with the sequoia trees which lay prostrate in the Calaveras grove, California, some enterprising vandals determined to fell one, which they did by using pump-augers, boring all around

Fig. 1936.



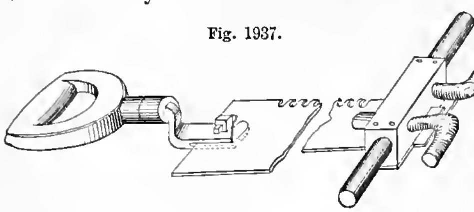
The Calaveras Redwood (Sequoia Gigantea)

towards the center. The tree was 92 feet in circumference and 300 feet in hight. It stood so plumb that when it was cut clear by the augers it stood upright and had to be upset by wedges. The stump was then adzed off for a dancing-floor.

These trees are situated about seventy-five miles east of Stockton, at an elevation of 4,700 feet above the level of the sea. The grove contains 92 trees, ten of which are 30 feet or more in diameter, 82 varying in diameter from 15 to 30 feet. In hight they range from 150 to 327 feet, the tops of many of the larger having been broken off by the wind or snow. The age of the trees is supposed to vary from 1,000 to 3,500 years.

Fell'ing-saw. This has a taper blade about 6½ feet long, with gullet-teeth, and operated like the cross-cut saw by a man or men at each end. The

Fig. 1937.



Felling-Saw.

handle at the wide end is fixed by an iron bolt and wedge. The handle at the narrow end is calculated for two men, and the saw is held in this handle by a wedge which is driven out when the saw is to be removed from the kerf. Wedges are driven into the kerf to prevent the blade from being jammed, and the saw is withdrawn from the kerf endways.

Fel'loe. The rim of a wheel or one of the annular segments thereof. See FELLY.

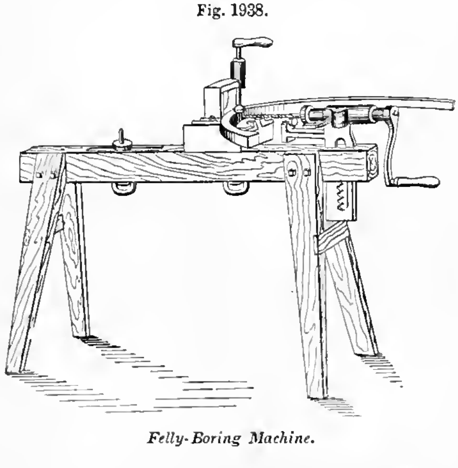
Fel'ly. (*Vehicles.*) A segment of the rim of a wooden wheel. When the perimeter is in one or two portions of bent stuff, it is a *rim*, or made of two *half-rims*. *Felloe.*

Fel'ly-au'ger. A hollow auger for fashioning the round tenon on the end of a spoke. A pod-auger for boring the hole in the felly to receive the spoke, or the holes in the ends for the dowel-pins.

Fel'ly-bend'ing Ma-chine'. A machine with a segmental or circular former around which felly-stuff is bent to a curved shape and held till it has cooled and dried in its assumed shape.

Fel'ly-bor'ing Ma-chine'. One having a vertically adjustable boring apparatus attached to an ordinary trestle, and with a clamp to hold the felly

Fig. 1938.

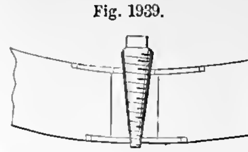


Felly-Boring Machine.

in position. Stops on the adjustable rest against which the bit-holder brings up limit the depth of the holes. At the front of the vise-block which holds the felly are two guide-irons, to keep the same in position when dowel-holes are bored.

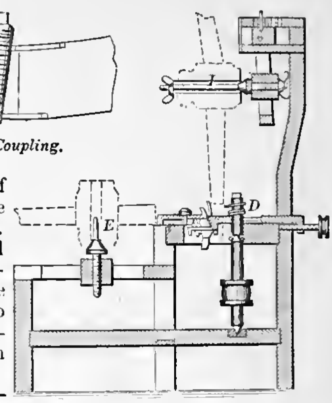
Fel'ly-coup'ling. A box for enclosing the adjacent ends of fellies in the rim of a wheel. The sectional block is expanded by the taper screw to expand the fellies and tighten the tire.

Fig. 1939.



Felly-Coupling.

Fig. 1940.

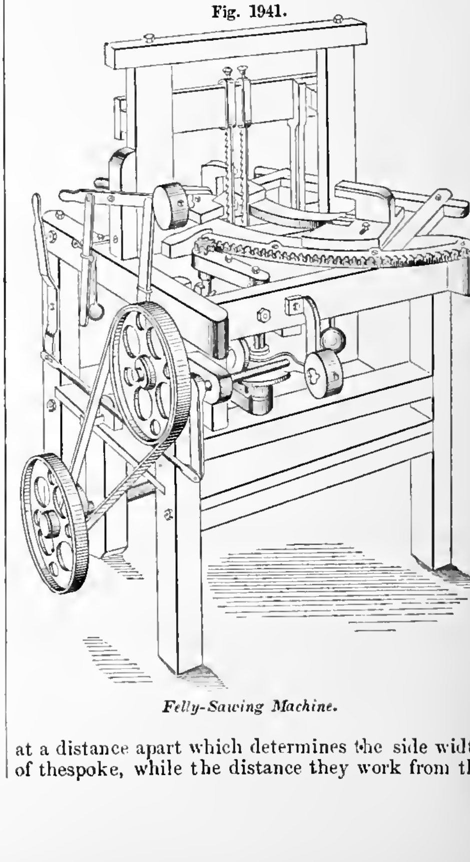


Felly-Dresser.

Fel'ly-dress'er. A machine for dressing the edges of fellies, the wheel being chucked upon a spindle *I* above so as to bring each part of the rim of the wheel in turn to the revolving cutter *D*. To dress the periphery of the rim, the wheel is chucked on the spindle *E*.

Fel'ly Saw'ing-ma-chine'. A machine for sawing stuff into fellies. The block is placed on a segmental bed which oscillates on a center and brings the stuff against a pair of gig-saws, which are gaged

Fig. 1941.



Felly-Sawing Machine.

at a distance apart which determines the side width of thespoke, while the distance they work from the center of oscillation of the swinging frame determines the radius of the circle of which the felly is an arc.

Felt. 1. (*Fabric.*) Fur and wool fibers have barbed surfaces inclined from the root towards their tips. Under the influence of friction and heat these barbs spread out from the main fiber, and, like the tendrils of a plant, catch hold of other fibers and cling to them. When a mass of such fibers are disposed in all directions, they readily interlock and consolidate into a compact fabric. As these barbs all incline in one direction, the fibers can readily work into a mass of fibers, partially felted, butt-end foremost. This is called *sizing*, and is produced in napping hats.

Felt probably preceded woven fabrics. In Central Asia, the home of the argali, from whence the domestic sheep has probably sprung, the clothing and tents of the people are yet, and have been since the first recorded times, felted fabrics. The latticed huts referred to by Herodotus and Æschylus are covered with felt, of which also the flapping screen which answers for a door is made. See WAGON. Marco Polo (thirteenth century) describes them fully. Klaproth describes them as of goat's hair (see HAIRCLOTH), and having a shaggy villus on the outside. The Chinese traveler, Chi-fa-hian, who visited India in the fourth century, describes the people of Chen-chen, who lived about the Lake of Loh, as wearing dresses of Chinese cut, but made of felt. Felt covered the funeral pile of Hephæstion, whose obsequies were so splendidly celebrated by Alexander; Xenophon says that felt was used to cover chairs and couches; the Medes also used felt for sacks.

The word *felt* is allied to the Greek *pilos* and Latin *pilus*, from a root word which means to *compress*. The Greek word *pilotos* — felted — comes strangely near the English *pilot*-cloth in name and meaning, not but that the latter is woven before being thickened by the act of compression (Latin, *cogo*, *coactus*, whence *coactilis*).

"Lanæ et per se coactæ vestem ficiunt."
PLINY.

The principal use of felt among the Greeks and Romans was in the manufacture of caps and hats. (See HAT.) The art of felting no doubt passed from Central Asia into Greece. In the time of Aristotle, besides the felt hats (*petasi*), the helmets were lined with felt (*pilos*) or sponge.

The mantles of Circassia and Phrygia to this day are heavy, stiff, and rain-proof. Colonel Leake describes a postilion's dress in Phrygia as a cloak of white camel's hair half an inch thick and stiff enough to stand alone when set on the ground. It had neither sleeves nor hood, but holes for the hand and projections like wings on the shoulders to turn off the rain.

The Armenians of Schamachi lead a nomadic life in movable huts constructed of wicker-work covered with felt, and with mats made of reed-grass.

The Nogai Tartars of the Caspian have similar shelters.

The hatters attribute the art of felting to Clement. The hatters are a very modern guild, and cannot antedate their order beyond the year 1400.

Dr. Hooke lectured on felt-making before the Royal Society, 1666. — PEPYS.

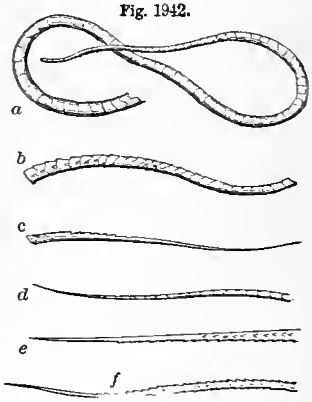
The mechanical features of the operation of felting are derived from the jagged character of the edges of some animal fibers, which enables them to pass in one direction, that is, root first, but opposes their withdrawal. The most familiar illustration of this feature is an awn of barley, a beard of wheat, or a head of grass of some kinds. These, as we all know, when introduced butt-first between the wrist and the sleeve, will crawl up the arm and strongly oppose withdrawal. The teeth are presented towards the point, and resist a force applied from that direction.

If we take a human hair, hold it fast by the root-end, and draw it gently between the finger and thumb, it passes smoothly and without sensible interruption; but if we reverse the direction of motion, a sensible crepitation is experienced. If we gently press a hair between the finger and thumb, and give it a rolling motion, it will advance root first, whatever may be the position of the root in respect to the two rubbing surfaces. A fiber of wool operates in the same way, moving root first; so do the hairs which are adapted for felting when similarly treated.

The jagged structure is visible in the beard of wheat and barley, and the microscope reveals it in the hair and wool referred to.

It would be interesting to introduce various other examples of hair and wool, as seen under the microscope, but our limits forbid. *a*, in the illustration, shows the appearance under a microscope of a fiber of Saxony lamb's wool somewhat less than $\frac{1}{1000}$ of an inch in diameter.

Fig. 1942.



Felting-Fibers.

f shows the appearance of rabbit-hair under the microscope, and *b* beaver-down, which has a diameter of about $\frac{1}{2000}$ of an inch. *c*, *d*, *e*, show musquash, nutria, and hare's fur. They all show the jagged edge which confers upon them the characteristic felting quality.

Wool in the yolk, with the natural grease (*suint*) adhering to it, will not felt, because in this state the asperities of the fiber are filled and smoothed over, just as oil destroys the action of very fine files. Fine wool that has been scoured has strong tendency to mat or felt together, and must be oiled to enable it to be carded and spun successfully.

The hair of rabbits, hares, and some other animals, is used in Russia as a felt foundation for bowls, dishes, plates, etc. It is brought to shape and then varnished; when complete, the utensil resembles papier-maché or varnished leather, and is light and durable.

English patent 1,403 of 1862 cites the use of the silky down of *typha* or bulrush. The down is separated from the seeds by a willowing process and blown over into a chamber. It is mixed with one third or half the quantity of rabbit's hair, and worked by the usual processes into hats, caps, and fabrics; or mixed with silk, wool, cotton, or flax to form a fabric for shoe-soles, paper, etc.; or mixed with caoutchouc or gutta-percha for bands, belts, carriage-fitting, accouterments, pipes; as a substitute for cork, book-covers, etc.

The uses of felt are various; among them may be cited the following: —

Among the Asiatics: cloth, hats, carpets, tent-coverings, socks.

In the United States and Europe, for domestic purposes: cloth, clothing, socks, slippers, boot and shoe soles and insoles, hats, caps, gloves, carpets, and table-covers.

Surgeons' bandages and saddle-cloths.

Mechanical: clothing for steam-boilers and cylinders; deadening for walls and floors; non-conductors for kilns and refrigerators; roofing charged with bitumen or other water-repellant; steam-packing; lining between the planking and copper-sheathing of ships; polishing-wheels; hammers of pianos; elastic blankets for printing-presses; covers of books.

2. The felted cloth on which paper is couched and carried in the paper-making machine. The cloth on which the paper is couched from the *making* cylinder is known as the *making* felt. Others as *carrying* felts, *first* felt, *second* felt, etc. Appurtenances of the *felt* are known as felt-washers, felt-rollers, etc.

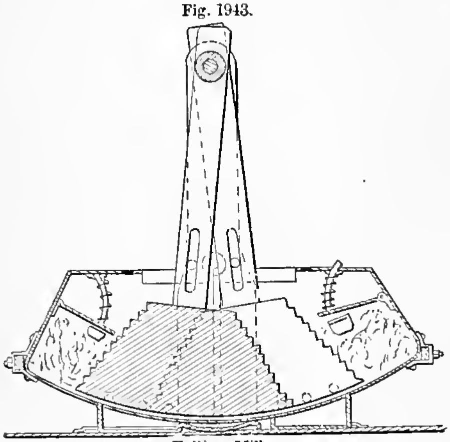
Felt-car′pet. A carpet whose fibers are not spun or woven, but are associated by the felting process.

Felt′ed Cloth. (*Fabric.*) Cloth made by felting, without spinning or weaving, was patented in England by Williams, in February, 1850.

Felt-grain. (*Wood-working.*) The grain of wood whose direction is from the pith to the bark; the direction of the medullary rays in oak and some other timber.

Felt′ing-ma-chine′. Felting-machines are of various kinds. 1. For acting upon the material in mass, as in the fulling-mill (Fig. 1943), where the cloth in a bath of soap-suds is pounded by the stock, which swings like a pendulum on its bearings above.

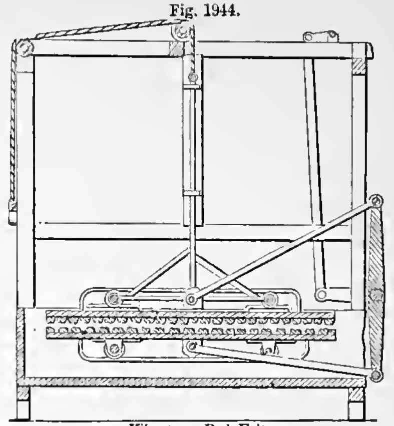
Fig. 1943.



Fulling-Mill.

2. A lower reciprocating bed mounted on grooved rollers running on tracks secured in the vat; the other bed being attached to grooved rollers that run between a double track above. The beds are worked in opposite directions by a double-action lever connecting therewith; the material placed between the beds and exposed to a rubbing action while immersed in hot water. (Fig. 1944.)

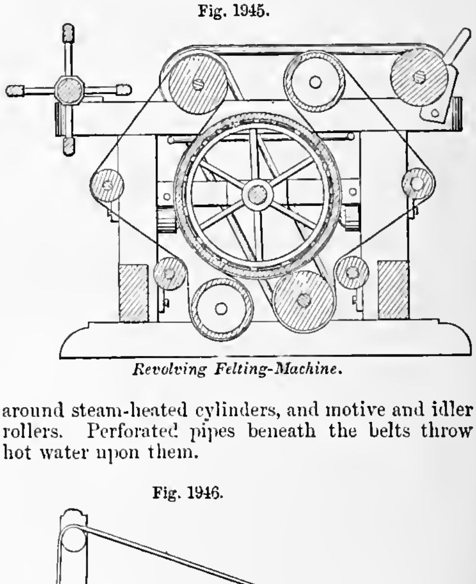
Fig. 1944.



Vibratory-Bed Felter.

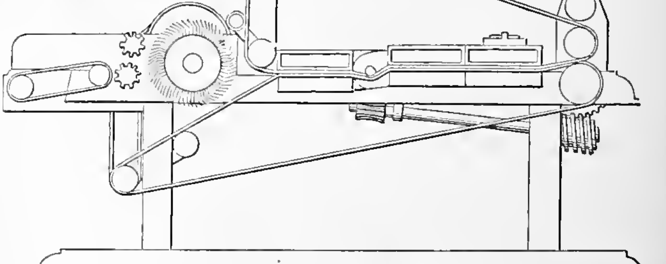
Fig. 1945 shows a form in which the main cylinder, having a cork surface, acts upon yarn or cloth carried between it and the fibrous belts which pass around steam-heated cylinders, and motive and idler rollers. Perforated pipes beneath the belts throw hot water upon them.

Fig. 1945.



Revolving Felting-Machine.

Fig. 1946.



Felt-making Machine.

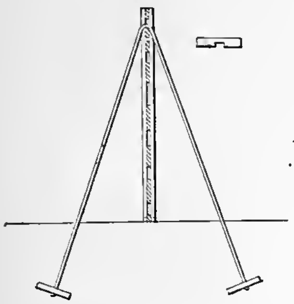
In Fig. 1946 the fiber is placed on a feed-apron, passes between two fluted rollers to a card-cylinder, and is then taken between two endless aprons over the series of tables, and beneath the longitudinally and transversely reciprocating platens. The combined heat, wet, and rubbing action consolidates the bat of fiber into a felted web.

Fe-luc'ca. (*Vessel.*) A small vessel propelled by oars and lateen sails; used in the Mediterranean and adjacent waters for coasting voyages.

Fem'er-ell. (*Carpentry.*) A louvre lantern in a roof for the escape of steam and smoke, or for ventilation.

Fence. 1. A structure on the boundary of a lot, field, or estate to keep off intruders, or act as a screen.

Fig. 1947.



Anchored Fence.

Among the varieties of fences are the *wall*, of brick or masonry; *post-and-board; post-and-rail; rail* or *worm* fence; *post-and-wire; paling; iron; portable; sunk* or *ha-ha; hedge.*

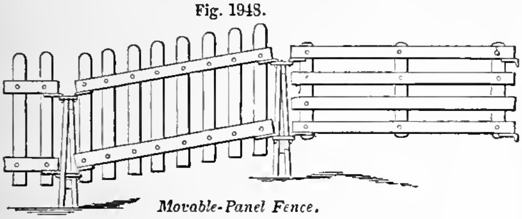
When stronger than most of these, the fence may rise to the dignity of a scarp, palisade, stockade, parapet, and constitute an important defensive line.

The Roman fences were four in number: —

1. The *Sepimentum naturale*, or live fence of thorn.

2. The *S. agreste*, or wooden paling interlaced with withes, or bored and strung on longitudinal rails.

Fig. 1948.



Movable-Panel Fence.

3. The *S. militaire*, having a bank (*agger*), ditch (*fossa*), and *vallum*, or row of stakes on the bank.

4. The *S. fabrile*, or wall of stone, brick, adobes, or mud.

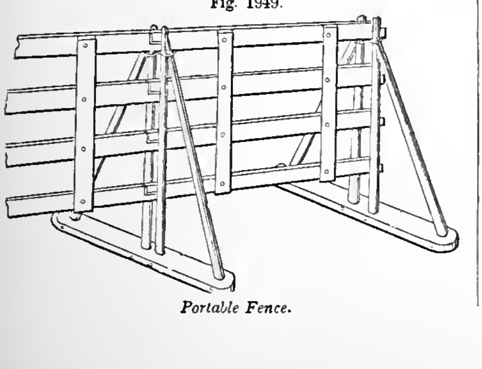
Room here can be afforded for but a bare hint of the diverse kinds.

Fig. 1947 shows a mode of supporting panels of board fence standing in line; stay-rods passing over the top of the fence and being anchored below the surface.

Fig. 1948 shows a mode of hanging fence-panels to posts.

Fig. 1949 is a portable fence in which the panels rest between posts which are planted in sills and stayed by inclined bars which form buttresses.

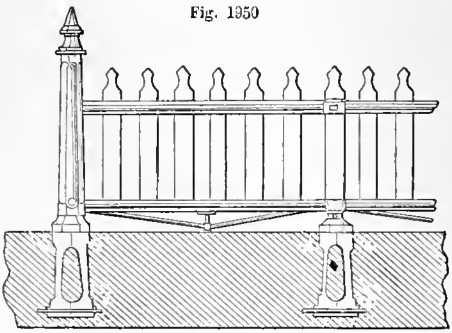
Fig. 1949.



Portable Fence.

Fig. 1950 is a more pretentious fence of iron posts set in grouting and ornamental panels.

Fig. 1950



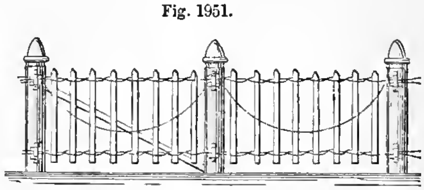
Iron Fence.

Fig. 1951 is a post, wire, and paling fence.

2. (*Wood-working.*) An adjustable guard-plate or edge on a gage, or on a *grooving, banding, plow, fillister*, or *reglet plane*, by which the distance of the groove from the guide-edge is regulated.

A straight edge on the work-table of a *circular, band*, or *scroll saw*, or of a *planing, molding*, or *mortising machine.* It acts as a gage and guide, and is adjustable to any required distance from the tool.

Fig. 1951.



Wire and Pale Fence.

The fence may be swiveled so as to have a capacity for angular presentation of the work.

3. The arm of the hammer-spring of a gun-lock.

4. (*Locks.*) An arm or projection which enters the gates of the tumblers when they are adjusted in proper position and coincidence, and at other times prevents such movement of the dog, stump, or other obstructing member as would permit the retraction of the bolt.

In common tumbler locks the fence forms the obstructing medium between the bolt and the tumblers, to prevent the retraction of the former when the tumbler-gates are not in coincidence.

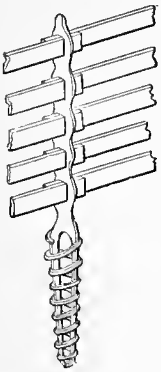
Fig. 1952.

Fence-Jack.

Fence-jack. A lever jack adapted for lifting the corner or *lock* of a worm-fence in order to lay in a new bottom-rail, a fence-chunk, or a stone.

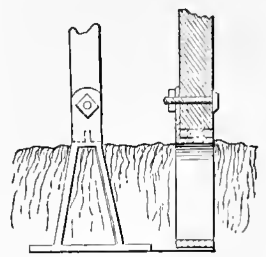
Fence-post. A piece of timber or a structure of other material, planted vertically in the ground, to hold panels of fence. Ingenuity has principally been exercised in contriving modes of saving timber in fences for prairie countries, and in structures as substitutes for the usual wooden posts. Two suggestive forms are shown in Figs. 1953 and 1954. One is an iron post with a spiral rib which answers as a screw for inserting it. The other is an anchor-block, to which the vertical slat of a fence is bolted.

Fig. 1953.



Screw-Post.

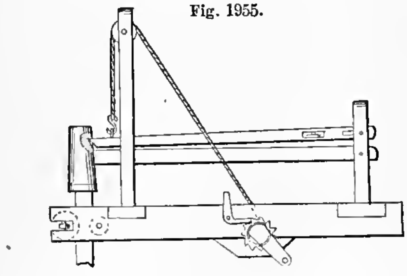
Fig. 1954.



Anchor-Block and Post.

Fence-post Driv'er. A device like a trip-hammer or pile-driver, mounted upon wheels, and used for driving fence-posts which have been previously sharpened. After the hammer attains its hight, the rope is cast off suddenly and the hammer drops.

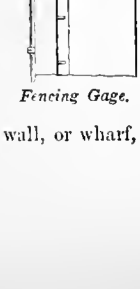
Fig. 1955.



Fence-Post Driver.

Fenc'ing-gage. An implement to space and hold boards against a post while nailing them. The upright cleat *A* is temporarily tacked to the post, and the pegs afford rests for the lower edges of the boards.

Fig. 1956.



Fencing Gage.

Fenc'ing-nail. A heavy nail of its class, adapted for fastening on fencing-boards.

6^d, 7^d, 8^d, 9^d, and 10^d nails are made for this purpose nearly twice the weight of the common nails of these numbers.

Fend'er. A contrivance to fend off an object so as to prevent the bruising of the structure so protected.

1. An upright timber placed against the edge of a pier, dock-wall, or wharf, to prevent injury to the wall by the contact of vessels, drift, or floating ice. A *fender-pile.*

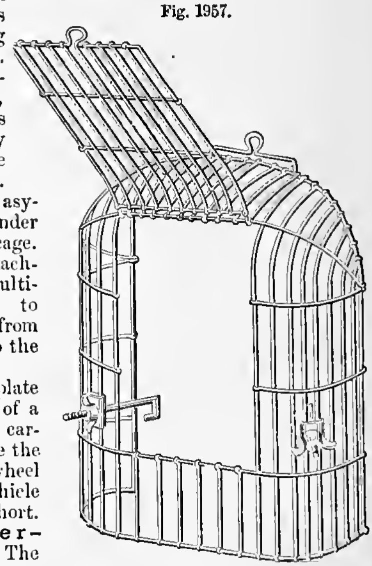
2. A mass of old rope stuffed into a heavy, open net made of rope, and placed between the sides of a vessel and the quay or pier with which it is about to collide, in order to deaden the blow and prevent injury to either of the contacting objects.

A piece of oak on a vessel's side to protect it from chafing by objects which are being hoisted aboard.

On the river steamboats of the West, poles hang overboard, being suspended from the upper guards, and answer the same purpose. Fancy rowing-boats, wherries, and man-of-war boats have fenders which hang outside the gunwale.

3. A structure in front of a fire or fireplace, to keep children or lunatics from burning themselves. In the example shown, the fender is secured by hooks to the grate-bars. In lunatic asylums the fender is a large cage.

Fig. 1957.



Fireplace Fender.

4. An attachment to a cultivator-plow to keep clods from rolling on to the young corn.

5. A rub-plate on the bed of a wagon or carriage to take the rub of the wheel when the vehicle is turning short.

Fend'er-beam. 1. The horizontal beam into which the posts of a saw-mill gate are framed at top. The fender-beam in Perley and Pattee's saw-mill at the Chaudiere Falls, Canada, is pine stock, 84 feet long and squared to 24 × 28 inches.

2. The inclined advance piece of an ice-breaker.

3. A beam suspended over a vessel's side to ward off ice and preserve the planking and sheathing of the vessel.

Fend'er-bolt. (*Shipbuilding.*) One having a large head which projects from the planking and serves as a fender to save the planks from being bruised.

Fend'er-pile. A pile fixed in front of a pier, wharf, or river wall, to ward off the blows of running ice, drift, vessels, etc.

Fend'er-post. One of the guiding stanchions of a saw-gate.

Fend'er-stop. (*Railroad Engineering.*) A structure at the end of a line of rails, to stop the carriages or engine, if needful.

Fe-nes'tra. (*Architecture.*) A window; an entrance.

Fe-nes'trai. Window-blinds or casements closed with paper or cloth, instead of glass.

Fer-ment'ing-square. (*Brewing.*) An oblong or square shallow vat in which wort is fermented.

Fer-ment'ing-vat. A tank or tun in which wort is placed to undergo the fermentation resulting from the addition of the yeast. Certain arrangements for keeping the liquid at the desired temperature in the heat of summer or cold of winter are added in some cases.

Fer-ran'dine. A mixed stuff of silk and other materials, formerly worn. It is referred to by Pepys in his "Diary," about 1667. The word was sometimes written *farandam* or *farendone*. It probably resembled *poplin*.

Fer'ret. 1. (*Glass.*) An iron used to make the rings at the mouths of bottles, or to try the melted matter.

2. *F oret*, or floss-silk.

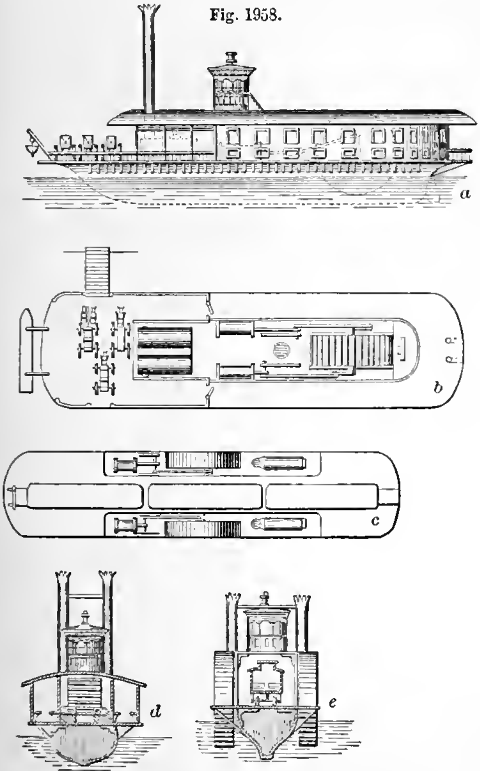
Fer-ret'to. (*Glass.*) A preparation of copper employed in glass-coloring. It is made by placing thin sheets of copper interstratified with powdered brimstone in a crucible which is luted tight and exposed to the heat of a blast-furnace for about two hours; when cool, the copper is found to be calcined so as to be readily crumbled between the fingers; it is then pulverized and sifted for use. A superior article to the foregoing is prepared by using vitriol instead of brimstone, and exposing the crucible to the heat of the glass-furnace for three days. The old vitriol is then replaced by fresh, and the heating operation repeated six times.

Fer'ro-type. (*Photography.*) A process, so named by Hunt, which derives its name from the material of the plate (iron) on which it is taken. Plates of sheet-iron are covered with a surface of black Japan varnish. This is immersed in collodion, and after a time in the silver solution. It is then placed in the holder and exposed in the camera.

Fer'rule. 1. A short tube or thimble made slightly conical, and used to fasten the tubes in the sheet-plates of steam-boilers. Except at the point, the ferrule is a little larger than the bore of the tube, and when driven in it compresses the tube forcibly against the sides of the hole in the tube-sheet, making a steam-tight joint.

2. A metallic ring or sleeve on the handle of a tool or the end of a stick, to keep the wood from splitting.

Fig. 1958.



Ferry-Boats.

Fer'ry-boat. (*Vessel.*) A vessel for carrying passengers and freight across a river or estuary.

a, an elevation of the steam ferry-boat for ordinary travel crossing the Missouri River at Omaha.

b is a plan-view of the same, showing the single wheel amidship, the engines and boilers.

d is a transverse vertical section of the same, showing the cabins over the guards.

e is a transverse vertical section of a ferry-boat for railway-cars at La Chine, river St. Lawrence. It has side-wheels and a track amidship.

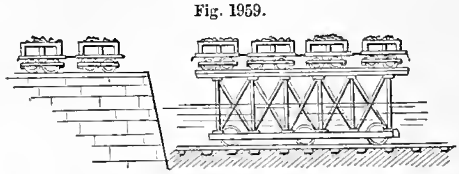
c is a plan-view of the same.

Fer'ry-bridge. A form of ferry-boat in which the railway-train moves on to the elevated deck, is transported across the water, and then lands upon the other side. Tramways forming inclined approaches are adjustable to the requirements of different stages of water in the river, or states of the tide in estuaries. The ferry-bridge which preceded the present bridge over the Susquehanna at Havre-de-Grace is a notable instance.

Ferry-bridges are also to be found in Europe, which cross by means of chains laid across the river, and chain-wheels on board rotated by an engine.

Fer'ry-rail'way. One whose track is on the bottom of the water-course and whose carriage has an elevated deck which supports the train.

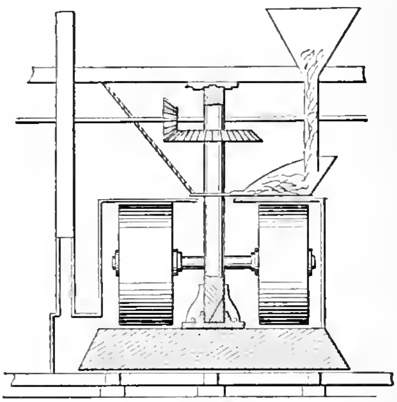
Fig. 1959.



Ferry-Railway.

Fer'ti-liz'er-mill. One in which the materials are ground to powder so as to be sown from a machine. The illustration shows a Chilian mill adapted to the purpose. Phosphatic minerals, bones, and various materials are thus ground.

Fig. 1960.



Fertilizer-Mill.

Fer′ti-liz′er-sow′er. A form of seeding-machine adapted to sow granulated manures, such as dry poudrette, the phosphates, bone-dust, lime, guano, etc. It sometimes forms a machine by itself, and sometimes is an attachment to a wheat-drill; in England, also to a turnip-drill.

Fes-toon′. (*Architecture.*) An ornament like a garland. Common on friezes.

Fet′lock-boot. (*Menage.*) A protection for the fetlock and pastern of a horse. See INTERFERING-ATTACHMENTS; LEG-GUARD.

Fet′ter. A chain for the feet. See HOPPLE.

Fet′tling. 1. (*Metallurgy.*) The material, consisting of ore, cinder, and scrap-iron, mixed in varying proportions, and used in preparing the hearth of a puddling-furnace before receiving its charge of iron. *Fettle* is an old English word signifying to prepare, and corresponds to the American word *fix*. *Fixing* is the term used in the United States to signify this preparation of the hearth.

2. (*Pottery.*) The shaving and smoothing of green clay-ware to remove the appearance of seams from articles that are molded, and to smooth asperities.

Feuil-lets′. (*Diamond-cutting.*) The projecting points of the triangular facets in a *rose-cut* diamond, whose bases join those of the triangles of the central pyramid.

Fi-a′cre. A French hackney-coach.

Fi′ber-gun. A device for disintegrating vegetable fiber. Lyman's patent, No. 21,077, of 1858. Flax, hemp, jute, cane, or wood are placed in a cylinder and charged with hot water, steam, gas, or air under great pressure; the cover of the cylinder being suddenly removed, the mass is projected into a chamber where the sudden expansion of the fluid under pressure ruptures the cells and tears the fibers apart.

Attempts have been made with more or less success to use this system of rapid exclusion of the matter, under pressure of generated carbonic acid, resulting from the treatment of the material first with a caustic alkali and then with acid. See COTTONIZING FIBER.

Fi′ber, Treat′ment and Man′u-fac′ture of. See list under COTTON, FLAX, WOOL, HEMP, etc., APPLIANCES.

Fib′u-la. (*Surgical.*) A needle for sewing up wounds.

(*Masonry.*) An iron crank by which stones are fastened together.

Fid. 1. (*Nautical.*) *a.* A bar of wool or iron to support a mast upon the one beneath. It passes through a mortise in the upper mast, and rests on the trestle-trees of the head of the mast below.

b. A wooden, pointed pin used to open the strands of a rope in splicing. A similar iron instrument is a *marlinspike*, or, as used by sail-makers, a *stabber*.

2. A plug of oakum for the vent of a cannon.

Fid′dle. 1. (*Music.*) An instrument played with a bow, and having four strings, stretched over a sounding-board to give resonance, and along a neck (without frets) upon which the strings are pressed by the fingers to vary the tone. See VIOLIN.

Locusts are fiddlers. Their hind legs are the bows, and the projecting veins of their wing-covers the strings. On each side of the body in the first segment of the abdomen, just above and a little behind the thighs, is a deep cavity closed by a thin piece of skin stretched tightly across it, like a banjo-cover. When a locust begins to play, he bends the shank of one hind leg beneath the thigh, where it is lodged in a furrow designed to receive it, and then draws the leg briskly up and down several times against the projecting lateral edge and veins of the wing-cover.

From a ballad of the fourteenth century, or thereabouts, cited in Watson's "History of English Poems," occurs, —

> "Syre Ladore latte made a feste
> That was fair and honeste,
> With his lord the kynge;
> Ther was much minstralse,
> Trompus, tabors, and santre,
> Both harp and fydyllynge."

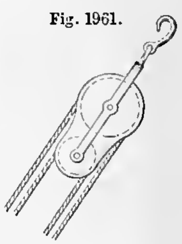
A monumental brass of the same period in St. Margaret's Church, King's Lynn, Norfolk, England, shows the musicians at a peacock feast; one has a four-stringed fiddle, another a six-stringed cithern.

2. (*Husbandry.*) A wooden bar about 11 feet long, attached by ropes at its ends to the traces of a horse, and used to drag loose straw or hay on the ground, or hay-cocks to the place of stacking. A rope or grape-vine answers very well for the latter purpose.

3. (*Nautical.*) A frame of bars and strings, to keep things from rolling off the cabin table in bad weather.

Fid′dle-block. A long block, having two sheaves of different diameters in the same plane; not as in a *double-block*, where they are in parallel planes. A *viol*-block.

Fig. 1961.



Fiddle-Block.

Fid-ham′mer. (*Nautical.*) A hammer with a face for striking and a pointed *peen* to act as a *fid*.

Field. The space visible in an optical instrument at one view. By shifting the telescope, the *field* is changed; by shifting the slip or object relatively to the object-glass of a microscope, successive parts of the object are brought within the *field*.

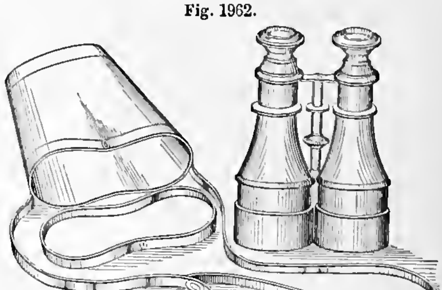
Field-bed. A folding-bed for camp use.

Field-book. The book in which the memoranda of surveys are made.

Field-der′rick. One used for stacking hay in the field. It is mounted on a sled or on a sill-piece which is anchored temporarily by stakes; otherwise it is stayed by guys.

Field-glass. 1. *a.* A binocular telescope in compact form, and having six achromatic lenses. It has a metallic body covered with morocco, and a sun-shade to extend over the object-glasses. It is carried in a leather case with a strap, and has a body 3¾ to 6¼ inches long, the object-glasses being from 15 to 26 lines in diameter. A *lorgnette*. An *opera-glass*. A *race-glass*.

Fig. 1962.



Field-Glass.

b. A small achromatic telescope, usually from 20 to 24 inches long, and having 3 to 6 draws.

2. That one of the two lenses forming the eye-piece of an astronomical telescope or compound microscope, which is nearest to the *object-glass;* the glass nearest to the eye is the *eye-glass.*

Field-gun. A light cannon designed to accompany troops in their maneuvers on the field of battle. At the commencement of the late civil war in this country, those thus denominated were the 6-pounder, weighing 885 pounds; the 12-pounder, of 1,770 pounds; a light 12-pounder of 1,220 pounds; and the 12, 24, and 32-pounder howitzers, weighing respectively 780, 1,320, and 1,820 pounds. These were all made of bronze. During the war several kinds of rifled field-guns were introduced, but only two maintained their place in the military service; the 3-inch wrought-iron rifle and the Parrott 10-pounder of 2.9-inch caliber, each nearly the weight of the bronze 6-pounder, and carrying an elongated projectile of ten pounds weight. The smooth-bores generally were withdrawn from the field during the war, with the exception of the light 12-pounder, or "Napoleon" gun.

Four smooth-bore guns and two howitzers, or six rifled or six 12-pounder guns with their carriages, caissons, forge, and battery-wagon, constitute a battery. No particular kind of breech-loading gun has been adopted in the United States Service, unless the Gatling machine-gun may be so classed. See BATTERY-GUN. Most, if not all, European governments have adopted breech-loaders of various kinds for field service.

The English use the breech-loading Armstrong gun (see ARMSTRONG-GUN) for field, fortification, and naval service.

The Prussian army uses two calibers of field-guns, 4 and 6 pounders, both rifled steel breech-loaders. The bore of the barrel extends entirely through. The breech of the 4-pounder is closed by a double wedge sliding in a horizontal slot through the barrel. The 6-pounder is closed by a plug held in place by a large steel pin. The escape of gas is prevented by a gas ring on the Broadwell plan, similar to that in a Sharp's rifle. See GAS-RING.

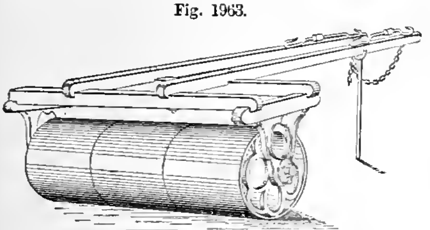
Field'ing. Exposure to the open air and sun of *malt-wash,* or *gyle* in casks, in order to promote its acetification.

Exposure to artificial heat is termed *stoving.*

Field-lens. See FIELD-GLASS, 2.

Field-roll'er. (*Husbandry.*) A wooden or iron

Fig. 1963.



Field-Roller.

cylinder, drawn over a plowed field to mash the clods and level the ground.

Field-staff. A gunner's staff for carrying a lighted match.

Field-tel'e-graph. One adapted for use in the field in military operations.

The field-telegraph of the German army consists of 140 men, 10 wagons, and 40 miles of wire for each army corps in the field. The wire is reeled out of the wagons and mounted on light poles about ten feet high, every third one being put in the ground. One eighth of the whole length of wire is insulated, and may be run along the ground.

Field-works. (*Fortification.*) These are of three kinds: —

1. Works open at the gorge: —
a. Redans, single and double.
b. Lunettes.
2. Works closed all round: —
a. Redoubts.
b. Star forts.
c. Bastioned forts.
3. *Lines,* continued or broken. See LINE.

Fife. (*Music.*) A small pipe used as a musical instrument; the usual accompaniment of the drum.

Fife-rail. (*Nautical.*) A banister on the break of a poop or around the mast of a vessel.

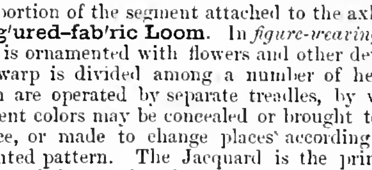
Fif-teenth'. (*Music.*) A stop of an organ tuned an octave above *principal;* two octaves above *open diapason.* See STOP.

Fifth-chain. The chain by which the single lead horse in a team of five is hitched to the end of the tongue. It is supported by chains from the harness of the leading pair.

Fifth-wheel. A wheel or segment above the fore-axle of a carriage and beneath the bed. The king-bolt is the center of oscillation, and the *fifth-wheel* forms an extended support to prevent the careening of the carriage-bed.

In the example, one part is shown in section to

Fig. 1964.



Fifth-Wheel.

exhibit the anti-friction rollers which traverse on that portion of the segment attached to the axle.

Fig'ured-fab'ric Loom. In *figure-weaving,* the cloth is ornamented with flowers and other devices. The warp is divided among a number of heddles which are operated by separate treadles, by which different colors may be concealed or brought to the surface, or made to change places according to a presented pattern. The Jacquard is the principal loom used in weaving figured fabrics. See DAMASK; JACQUARD.

Hohlfield, of Hennerndorf, in Saxony, 1711–71, invented a loom for weaving figured fabrics, the model of which is preserved in the collection of the Berlin Academy.

Fig'ure-head. (*Nautical.*) The ornament on the head or prow of a ship.

Fi'lar-mi-crom'e-ter. A micrometer having threads or wires across its field of view. It was invented by Malvasia about 1660, who applied a net-work of fine silver wires crossing each other at right angles, and dividing the field of the telescope into squares. See WIRE-MICROMETER.

File. A steel instrument for abrading or smoothing surfaces, and having raised cutting edges (teeth) made by the indentations of a chisel.

Files are mentioned in 1 Samuel xiii. 21, 1093 B. C. "They had a file for the mattocks and for the colters, and for the forks and for the axes, and to sharpen the goads."

Files are graded by *shape*, *size*, and *fineness* of cut; and also known by their *purpose*.

As to *shape*, the diagram (Fig. 1965) giving a series of sections will be readily understood.

a, b, c, d, e, f, g, h, are sections derived from the square.

i, k, l, m, n, o, p, q, are sections derived from the circle.

r, s, t, v, w, x, y, z, are sections derived from the triangle.

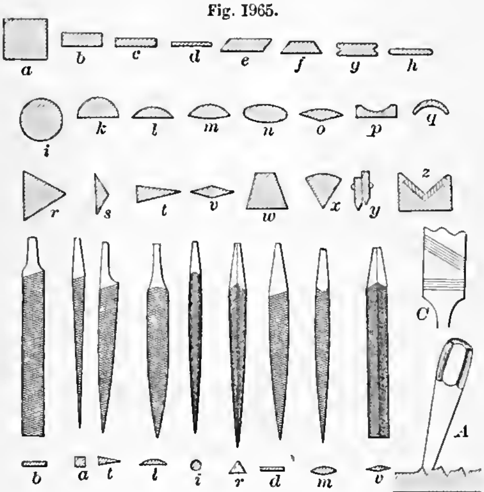
a, *square* file, parallel or taper, sometimes with a *safe* side.

b, when large, a *cotter* file; small, *verge* or *pivot* file.

c, *flat* file: when small, *pottance* file; when narrow, *pillar* file.

d, when *parallel*: *equaling*, *clock-pinion*, or *endless-screw* file. When *taper*: *slitting*, *entering*, *warding*, or *barrel-hole* file.

Fig. 1965.



Files.

e, f, *French-pivot* or *shouldering* file; *parallel V*-file.

g, *nail* file, for the finger-nails.

h, *pointing mill-saw* file, *round-edge* file.

i, *round*, *gulleting*, *rat-tail* file.

k, *frame-saw* file.

l, *half-round* file; *nicking*, *piercing*, or *round-off* file.

m, *cross* file; *double-half-round* file.

n, *oval* file.

o, *balance-wheel* or *swing-wheel* file, the convex side only cut.

p, *swaged* file, for finishing brass-moldings.

q, *curvilinear* file.

r, *triangular*, *three-square*, or *saw* file.

s, *cant* file, for filing inside angles of 120°.

t, when parallel, *banking* or *watch-pinion* file; when taper, *knife-edge* file.

v, *screw-head*, *feather-edge*, *slitting* file.

w, *valve* file.

x, *triangular-and-half-round* file.

y, *double* or *checkering* file, for gunsmiths.

z, *double*, or *pencil-sharpening* file.

Other grades of files are known by peculiarities of form not shown by section; such as:—

Taper; thinner towards the point.

Parallel; the same dimensions throughout the length.

Blunt; a grade between taper and parallel.

As to character of teeth, the classes are:—

Double-cut; having two sets of teeth crossing obliquely.

Single-cut or *float;* having but one row of teeth.

Rasp; having detached teeth made by a punch, instead of a chisel.

A (Fig. 1965) shows the position and action of the file-chisel on the blank *B*; *C* the appearance of the rows of teeth. The lower row should, however, have been shown as not quite squarely across the face of the file.

As to relative fineness of teeth:—

Rough-cut.	Second-cut.
Middle-cut.	Smooth.
Bastard.	Superfine or dead smooth.

Approximate number of cuts in an inch of files:—

Length of File in Inches.	4.	6.	8.	12.	16.	20.
Rough . . .	56	52	44	40	28	21
Bastard . .	76	64	56	48	44	34
Smooth . . .	112	83	72	72	64	56
Superfine . .	216	144	112	88	76	64

See any in the following list, under their alphabetical heads:—

Angular-file.
Arm-file.
Balance-wheel file.
Barrel-file.
Bastard-file.
Blunt-file.
Bow-file.
Bread-rasp.
Cabinet-file.
Cant-file.
Carlet.
Checkering-file.
Circular-file.
Cobler.
Concavo-convex file.
Cotter-file.
Cross-file.
Cutting-file.
Dead-smooth file.
Dental-file.
Double-file.
Double-cut file.
Double half-round file.
Double-tang file.
Dovetail-file.
Entering-file.
Equaling-file.
Feather-edge file.
File-blank.
File-blanks. Rolling
File-carrier.
File-chisel.
File-cleaner.
File-cutting machine.
File-sharpening.
File-stripper.
Filing-block.
Filing-machine.
Filings-separator.
Flat-file.
Float.
Found.
Graille.
Half-round file.
Half-thick file.
Hand-file.
Hollow-edge file.
Joint-file.
Key-file.
Knife-file.
Lock-file.
Marble-workers' file.
Middle-cut file.
Molding-file.
Nail-file.
Nicking-file.
Oval file.
Parallel-file.
Parting-tool.
Perforated file.
Piercing-file.
Pillar-file.
Pinion-file.
Pivot-file.
Pottance-file.
Quannet.
Rasp.
Rasp-cutting machine.
Rasper.
Rasp. Mechanical
Rat-tail file.
Riffler.
Rough-file.
Round-file.
Round-edge file.
Round-off file.
Rubber-file.
Safe-edge file.
Saw-file.
Saw-filing machine.
Second-cut file.
Screw-head file.
Shouldering-file.
Single-cut file.
Slitting-file.
Smooth-file.
Square-file.
Superfine-file.
Swing-wheel file.
Taper-file.
Three-square file.
Topper-file.
Triangular-file.
Turn-file.

Valve-file.	Watchmakers' file (varieties, see WATCHMAKERS' FILES).
Verge-file.	
Warding-file.	

The sculptor's file is known as a *riffler*, and is curved in various forms. Hiram Powers's file is perforated to allow escape of plaster or marble-dust.

The method of handling the chisel depends in great measure on the kind of tooth to be cut. The file is held to its place on the leaden anvil by means of a leathern strap passing over each end of the file, and then under the feet of the workman in the manner of stirrups. At every blow of the hammer the chisel is made to cut a tooth, and the blows follow each other in rapid succession, the workman after every blow advancing the chisel forward by a slight movement. The chisel forms a number of angular grooves parallel to each other, the tooth being formed by the metal raised between every two grooves. As the work proceeds, he shifts the file forward by loosening his tread upon the straps. When one surface is covered with single cuts, he proceeds, in double-cut files, to add a second row of teeth, making them cross the former obliquely.

The files are next hardened, unless they are to be used upon wood, ivory, and other soft substances; such files admit of being sharpened up with a hand-file. Some of the curved files used by sculptors and die-sinkers are made of iron and case-hardened.

Mr. Holtzapffel describes the operation of cutting in the following terms: "The first cut is made at the point of the file; the chisel is held in the hand at a horizontal angle of about 55° with the central line of the file, as in the upper row of cuts at *C*, and with a vertical inclination of about 12° to 14° from the perpendicular, as represented at *A*." (Fig. 1965.)

"The blow of the hammer upon the chisel causes the latter to indent and slightly to drive forward the steel, thereby throwing up a trifling ridge or bur; the chisel is immediately replaced on the blank and slid from the operator, until it encounters the ridge previously thrown up, which arrests the chisel or prevents it from slipping farther back, and thereby determines the succeeding position of the chisel. The heavier the blow, the greater the ridge, and the greater the distance from the preceding cut at which the chisel is arrested. The chisel, having been placed in its second position, is again struck with the hammer, which is made to give the blows as nearly as possible of uniform strength; and the process is repeated with considerable rapidity and regularity, sixty to eighty cuts being made in one minute, until the entire length of the file has been cut with inclined, parallel, and equidistant ridges, which are collectively denominated the first course. So far as this one face is concerned, the file, if intended to be single cut, would be then ready for hardening. Most files, however, are double cut; that is, they have two series or courses of chisel cuts. In cutting the second course, the chisel is inclined vertically as before, at about 12°, but its edge only a few degrees from the transverse line of the file, or about 5° to 10° from the rectangle. The blows are now given a little less strongly, so as barely to penetrate to the bottom of the first cuts, and from the blows being lighter they throw up smaller burs, consequently the second course of cuts is somewhat finer than the first. The two series, or courses, fill the surface of the file with teeth, which are inclined towards the point of the file." See Holtzapffel's *Turning and Mechanical Manipulation*, London, 1847.

File-blank. A piece of soft steel, shaped and ground ready for cutting, to form a file.

File-car'ri-er. A tool-holder like the stock of a frame-saw, and used to mount a file in a manner similar to that of the saw in the case cited.

Fig. 1966.

File-Carrier.

File-chis'el. The cold chisel (*A*, Fig. 1965) for rough files is about 3 inches long, 2¼ wide, and the angle of the edge is about 50°. (See FILE.) The edge is straight. The file-blank rests upon a block of lead which forms the anvil. The narrower chisel, for cutting smaller and smoother files, has a length of about 2 inches, width ½ inch. It is very thin and sharpened to an angle of about 35°. It is used with a hammer weighing one or two ounces. Other chisels are of intermediate proportions. The edge is always wider than the file to be cut.

The chisel is held in the left hand at an inclination of 4° to 15° from the perpendicular, according to the character of the file.

The blow of the hammer drives forward the chisel, raising a bur, the hight of which determines the distance of the next cut, as the sliding of the chisel against the ridge previously thrown up affords a gage for the position of the chisel at the next blow, the operator being guided by the sense of touch. The cuts are made at the rate of 60 to 80 per minute. The file-blank is greased before cutting.

File-clean'er. A scratch-brush of wire. A thin brass edge which acts as a rake. A card such as is used in carding cotton.

To remove wood, dip the file in hot water to swell the wood. It is then removed by a hard brush; the warmth evaporates the moisture.

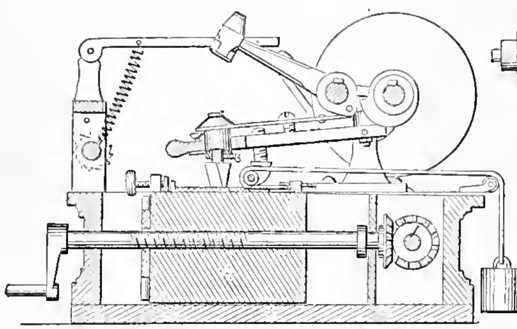
File-cut'ting Ma-chine'. A machine by which files are cut automatically. The usual form has a table to which the blank is secured, and on which it is fed beneath the chisel, which receives the blows of a trip-hammer above.

Many attempts have been made in this direction in France, England, and the United States. Among these may be mentioned Duverger, 1699; Fardouet, 1725; Thiout, 1740; Brachal and Gamain, 1756, 1778; Raoul, 1800; Ericsson, 1836; Robison, 1843. See also Skilton's machine, "Ure's Dictionary," Vol. II. pp. 202–204, edition of 1860. See also "Transactions of the American Philosophical Society," Vol. II., in which a machine is described in which the file is fixed on a bed of lead, and a chisel fixed at the end of a lever is struck down by a hammer. The lever is again raised by means of a spring, and during its rise moves a ratchet-wheel connected with the support of the bed, which is shifted, together with the file, after each stroke. In Thiout's machine ("Traité de l'Horologie," Paris, 1740), the file is attached to a screw-slide suspended at the end by pivots and covered with an anvil-plate of tin. The slide works upon a stationary anvil, and is worked by a feed-screw moved at intervals the distance of the pitch of a tooth by means of a pin-wheel. The chisel is held on a jointed arm beneath which is a spring to raise it after each blow, the latter being given by a vibrating drop-hammer. Ericsson's machine was adapted to cut several files at a time, and is especially commended for the introduction of means by which, in cutting taper files, the hammer is less raised in cutting the ends of the files than at the middle, so as to proportion the force of the blow to the width and depth of the cut at different parts of the file. Two machines were used for double-cut files, the bed of one inclined to the right and the other to the left, to give the different horizontal inclinations proper to these teeth, and a machine with a straight bed was used for single-cut *floats*, and for round and half-round files. The machines make about 240 strokes per minute, which is about three times the rate of hand-work, and two beds are employed, so that one may be cutting while the blanks are being adjusted upon the other.

Sir John Robison, formerly president of the Royal Scottish Society of Arts, suggested, in 1843, the making of curvilinear files by cutting flat strips of steel plate and then rolling them into shape and tempering them. Cammel's improvement was to make the plate thinner towards the edges, so that it might bend equally, and not too much in the middle, as it was apt to do when of an even thickness. He also suggested to make the teeth by a graver, in an automatic machine.

Fig. 1967 shows a file-cutting machine in which

Fig. 1967.

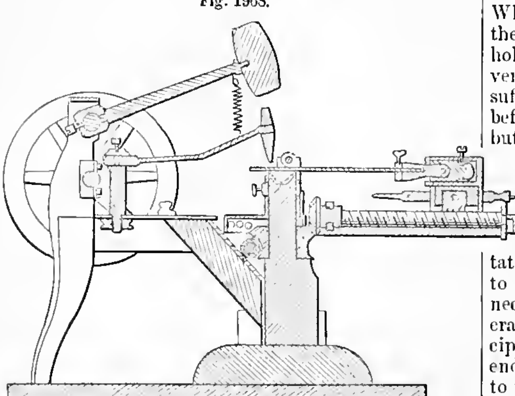


Rotherham and Holden's File-Cutting Machine.

the blanks are secured side by side on the upper surface of the bed, which is automatically fed after each stroke by the feed-screw; a separate chisel and hammer act upon each blank; the chisels are supported by springs on arms with roller feet, which bear upon the blank; the chisels are thrown back after each cut to raise a burr.

In Fig. 1968, the sliding head to which the shank of the blank is clamped is actuated by a feed-screw and half nut, the latter being automatically raised to stop the feed-motion at the proper time. The anvil has a hemispherical block, whose convex side rests in a socket of its support. The anvil and feed-

Fig. 1968.



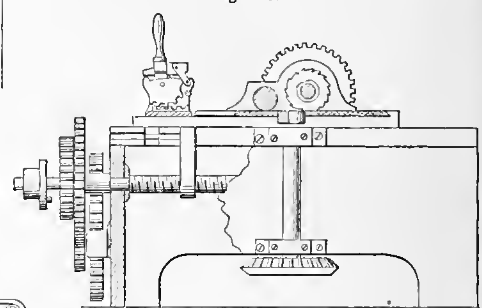
Card and Studley's File-Cutter.

movement are supported on a turn-table, by whose adjustment the inclination of the teeth is determined. The chisel is supported upon a flexible rod which is connected to the hammer-handle by a spiral spring. The hammer is attached to a rock-shaft, which has an adjustable arm acted on by a cam on the main shaft.

File-grind′ing Ma-chine′. A machine for surfacing forged or rolled file-blanks to bring them to form previous to cutting.

In the example the files are secured one after another upon a carriage which moves under a revolving cutter on a curved bed in such a manner that

Fig. 1969.



File-Grinding Machine.

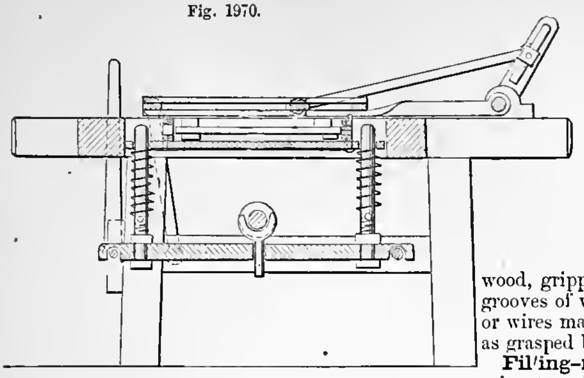
the shape of each file depends entirely upon the curvature of the bed; and as long as this curvature remains unchanged, all the files turned out upon it are uniform in shape. The files are held in position upon the carriage by a sliding clamp operated by a toothed segment. This segment connects with a hand-lever in such manner that when the clamp has been made to catch over the end of the file, the toothed segment is locked and the clamp thus prevented from spontaneously releasing the file.

Fil′er. An office device for holding bills and loose papers. See PAPER-FILE.

File-sharp′en-ing. Worn files are first cleaned by hot water and soda; then placed in connection with the positive pole of a battery, in a bath composed of forty parts of sulphuric acid, eighty parts of nitric acid, and a thousand parts of water. The negative pole is formed of a copper spiral surrounding the files, but not touching them; the coil terminates in a wire which rises towards the surface. When the files have been ten minutes in the bath they are taken out, washed, and dried, when the hollows will be found to have been attacked in a very sensible manner; but should the effect not be sufficient, they are replaced for the same period as before. Two operations are sometimes necessary, but rarely.

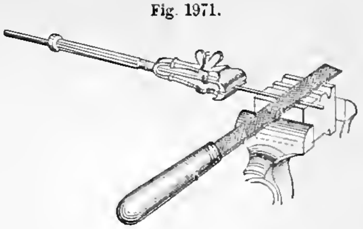
File-strip′per. A machine in which a worn-out file, after being softened by heat and slow cooling, is smoothed to prepare it for being re-cut. In the example, the file is held by adjustable jaws upon a slightly rotating bed supported by springs. The cross-bar, to which the stripping-tool is attached, is connected at each end by a connecting rod with a crank upon the end of the driving shaft, and is reciprocated in guides upon a frame hinged at one end to the driving-shaft, and which may be elevated to raise the stripper off the file through the instrumentality of a rock-shaft and a system of levers at the other end.

Fig. 1970.



File-Stripper.

Fig. 1971.



Filing-Block.

File-tem'per-ing. The files are drawn through beer-grounds, yeast, or other adhesive fluid, and then through common salt mixed with roasted and pounded cow's hoof, the objects of which are to protect the teeth from the direct action of the fire and the oxidizing influence of the air; to afford an index of temperature, the fusion of the salt showing when the hardening heat is attained; and to lessen the tendency of the files to crack on being immersed in water. The file is held by the tang with a pair of tongs, and immersed quickly or slowly, vertically or obliquely, according to its form; that method being adopted which has been found by experience best calculated to keep the file straight. After the hardening, the tang is tempered by immersing it in molten lead; if the tang were left as the file, it would be liable to snap off during use.

The files are next scoured with scrubbing-brushes dipped into sand and water or coke-dust and water; they are next put into lime-water and left for some hours. They are then thoroughly dried at the fire, and lastly rubbed over with olive-oil containing a little turpentine.

Fil'i-gree. Delicate jewelry-work of gold or silver wire drawn flat or round. The wire is twisted by pinchers into beautiful forms, and soldered at the junctions.

The word is Italian. The original form seems to have been a wire with grains or beads, and the term now includes plaited, interlacing, or granular work in gold or silver wire worked into ornamental forms. The nations bordering on the Mediterranean excel in the art.

The filigree of India comprises various personal ornaments of gold and silver, groups of flowers, and small boxes and caskets. Their apparatus consists merely of a few small crucibles, a piece of bamboo for a blowpipe, small hammers for flattening the wire, and sets of forceps for interweaving it.

Fil'i-gree-glass. (*Glass.*) One of the kinds of ornamental glass for which Venice was formerly celebrated, and which has been recently revived.

Small filigree canes of white and other colored enamels are drawn; *whetted* o f the required lengths, arranged in clusters in a cylindrical mold of the required shape, and then fused together by heat. The canes are then aggregated by flint glass at a welding heat, and the mass twisted if a spiral ornament be desired. Vases or other objects are made of ornamental masses of this glass, blown in the usual manner.

The *Venetian ball*, familiar in paper-weights, is made of waste pieces of filigree in a pocket of flint-glass.

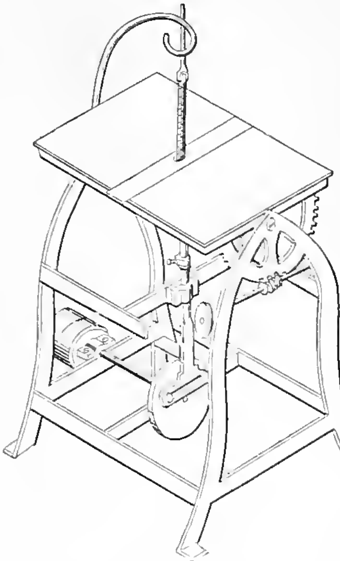
Fil'ing-block. A block of apple, pear, or boxwood, gripped in the jaws of a vise, and having grooves of varying depth in which small rods, bars, or wires may be laid to be filed. The wire is shown as grasped by a hand-vise.

Fil'ing-ma-chine'. 1. A machine used in the mint to reduce the weight of coin planchets, when above the standard. The pieces are laid parallel in a trough, and their edges rest upon a cylindrical file, whereby a portion of metal is removed, the pieces rotating as the work proceeds, in order to preserve their circularity.

2. A machine in which a file is mounted as a jig-saw; or to reciprocate in a manner similar to that of a file in the hands of a workman.

In the example, the file receives vertical reciprocation from a pitman whose cross-head has a horizontal slot traversed by a crank-pin on a rotating

Fig. 1972.



Filing-Machine.

disk. The table is pivoted and has a semicircular rack which is engaged by a screw-gear to incline the table. See also SAW-FILING MACHINE.

Fil'ings-sep'a-ra'tor. A machine in which filings of iron and copper are separated by exposure to magnets which are brought into contact with all of the particles, and select, retain, and remove the iron particles from those of brass and copper, so that the latter may be used for re-melting. There are several forms of machines for the purpose.

Fil'let. 1. A strip of card-clothing. A strip of leather furnished with the bent wire teeth peculiar to carding-engines.

2. A ring on the muzzle or cascabel of a gun.

3. A ribbon of metal of gaged proportions fed to the machine which punches out the planchets for coining.

4. (*Carpentry.*) *a.* A square molding, frequently forming an upper finish or *corona.* A *band* or *listel.*

b. A strip nailed to a wall or partition to support a shelf.

c. A stop for room or closet doors to close against.

d. A strip inserted into the angle formed by two boards or surfaces.

5. (*Dairy.*) A perforated curb to confine the curds in making cheese.

6. (*Bookbinding.*) A rolling tool which has a plain line, lines, or band; differing in this respect from the ornamental rolls.

7. (*Architecture.*) The projection between the flutes of a column.

8. (*Printing.*) A rule with broad or broad and narrow lines, principally used as a border.

9. (*Gilding.*) A band of gold-leaf on a picture-frame or elsewhere.

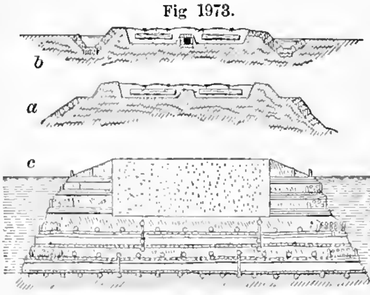
10. The thread of a screw.

Fil′let-plane. A molding-plane for dressing a fillet or square bead.

Fill′ing. 1. (*Railroading.*) An embankment of stone, gravel, earth, etc., to make a raised bed for a road, railroad track (*a*), or canal. An artificial, elevated way.

In the laying out of a permanent way, it is usual to make the *cuttings* and *fillings* counterbalance each

Fig 1973.



Filling.

other, as near as may be, but in a flat country the *way* is made by throwing the sides to the middle, making a bank bounded by two ditches (*b*). The customary soil in such situations, however, is unfit for the repose of the ties, and it becomes necessary to carry sound ballast, such as broken stone or good gravel, before the *permanent* way can be said to be in good order. Such is especially the case in ground naturally swampy. In such cases the track is either supported by piles, or, as in the annexed illustration (*c*), which represents a railroad embankment in Holland, by fascines and stakes, bound together and placed alternately across and longitudinally.

Among the largest embankments of modern times are the Tring filling of the Northwestern Railway, England, containing 1,500,000 cubic yards; the Gadelbach, on the Ulm and Augsburg Railroad, 1,750,000 yards; the Oberhäuser, on the Augsburg and Lindau Railway, 2,500,000 cubic yards.

Chat-Moss, on the Liverpool and Manchester Railway, is $4\frac{1}{2}$ miles across and from 20 to 40 feet deep. Cattle could not stand upon it. To form an embankment of 277,000 yards, 670,000 yards of material were thrown into the bog.

2. (*Shipbuilding.*) Pieces or composition fitted in between the frames of the hold, to increase the water-tightness, resist compression, and prevent the collection of dirt, bilge-water, and vermin. Blocks of wood, bricks, mortar, cement, asphalte, have been used.

3. (*Nautical.*) A slip of wood forming a part of a built structure, such as a made mast; or a piece inserted to fill a defect.

The covering of a pile, below water, with broad-headed nails, to exclude the *Teredo navalis.*

4. (*Weaving.*) The *weft*-thread which fills up the *warp*, being introduced by the shuttle and beaten up by the *batten* or *lathe.* Also known as the *woof*, *shoot*, or *tram.*

5. A stopping for carious teeth. The filling of decayed teeth with gold was practiced by the Egyptians, as is proved by some mummies found at Thebes. See DENTAL INSTRUMENTS AND APPLIANCES.

Fill′ing-en′gine. (*Silk-machinery.*) A machine in which waste and floss silk from the regular silk-machinery is disentangled, and the fibers laid parallel. The silk, previously hackled, is fed between rollers and subjected to the action of a series of moving combs. It then passes to the *drawing-frame*, where it is subjected to a farther process of substantially similar character. From the *drawing-frame* it passes to the *scutcher*, and thence to the *cutting-engine*, which cuts it into lengths of about $1\frac{1}{4}$ inches. The staple is then cleansed, dried, and eventually *carded* and *doubled*, *drawn* and *spun*, like cotton.

Fill′ing-in Pie′ces. (*Carpentry.*) Timbers occurring in partitions, groins, and roofs of less length than those with which they range; as the jack-rafters next a hip, and the short rafters filled in the side of a roof next the chimney-shaft.

Fill′ing-pile. (*Hydraulic Engineering.*) A backing or retaining pile in a coffer-dam.

Fill′ing-post. (*Architecture.*) A middle post in a wooden frame.

Fill′ing-tim′bers. (*Shipbuilding.*) Those placed between the frames to fill up.

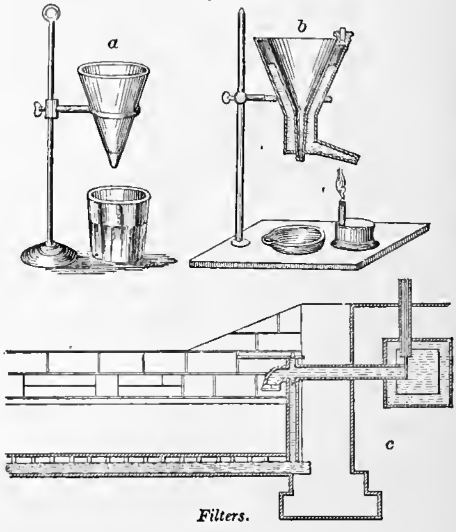
Fil′lis-ter. 1. The rabbet on the outer edge of a sash-bar, to hold the glass and the putty.

2. A plane for making a rabbet. The varieties are known as *side*-fillisters and *sash*-fillisters.

The former is regulated for depth by a movable stop. See PLANE.

Fil′ter. A vessel, chamber, or reservoir through

Fig. 1974.



Filters.

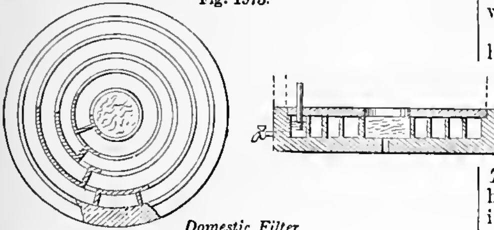
which water or other liquid is passed to arrest matters mechanically suspended therein. The idea does not necessarily include specific chemical action, though doubtless animal and vegetable charcoal have a faculty for absorbing gases and deleterious and effete matter, especially organic.

The filter (*a*, Fig. 1974) of the laboratory is made of a circle of bibulous paper, folded and opened into a quadrant and inserted into a funnel of glass or porcelain, and the filtering material is a quadrant of bibulous paper which is rolled into a cone and fitted into the funnel. Crushed and powdered glass, and gun-cotton are also used.

The filter *b* (Fig. 1974) is placed within a water bath which has a leg heated by an alcohol lamp. This is used for filtering matters which become viscid by cooling, such as gelatine, tallow, wax, stearic acid, etc. All filters for the laboratory, in which a sheet of paper is made to line a funnel and contain the liquid, should have sides subtending an angle of 60°; this for the reason that a sheet of paper folded in four, and one corner opened so as to form a cone, fills a funnel of the shape described.

The domestic filter frequently consists of a submerged jar or box made of a natural or artificial po-

Fig. 1975.

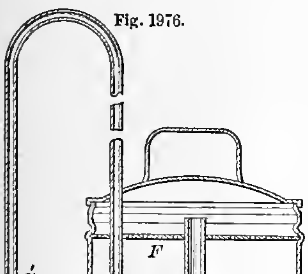


Domestic Filter.

rous stone, through which water passes, and which is withdrawn by a faucet which crosses the intervening space and passes to the outside. In another form it is a chamber at the bottom of the water-reservoir, as in Fig. 1975. The water passes down into the sponge-pocket, and thence follows around the circuitous chamber charged with filtering material to the outlet.

In another form, the filter is placed within a barrel, and the water passes through a coarse filter *D* beneath it, and up a central tube *C* to an upper chamber, and from this chamber through the filtering material contained between two perforated diaphragms *F G*. The water is drawn from the lower annular chamber by a siphon *G′* having a stop-cock at its lower end.

Fig. 1976.



Siphon-Filter.

A good domestic form consists of a deep wooden tub divided by a tight vertical partition through the middle, the partition at the bottom being perforated with numerous small holes. The tub is nearly filled on both sides of the partition with granulated charcoal made from sugar-maple, and screened through a mesh of one sixteenth of an inch, the fine dust being separated by bolting. The foul water enters the tub on one side at the top, passes downward and through the small holes in the partition, and rises upward on the other side, leaving its impurities, both solid and gaseous, in the charcoal.

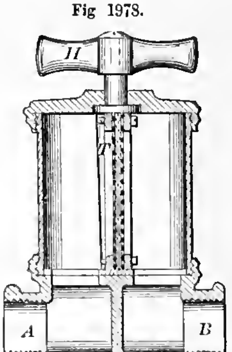
Fig 1977.

Filter and Cooler.

Fig. 1977 shows a filter and cooler combined. The water from the reservoir *A* above passes into a tube *B*, whose mouth is vertically adjustable, and is introduced below the filter-bed *E*, through which it passes upward into the ice-chamber *K*.

Fig. 1978 is a reversible filter interposed in a length of pipe. The water flowing from *A* to the filtering-surface *T* has its impurities detained, while the strained water runs off at *B*, and pursues its course along the pipe. When the filter-surface *T* has become foul, the handle *H* is turned, throwing the dirt to the delivery side, by which it is carried off, the water being allowed to run to waste until the surface is cleansed and the water runs clear.

Fig 1978.



Reversible Filter.

The filter for rain-water is a part of, or is placed at, the end of the spouting or conductor for the rain-water.

It is usually a box or chamber containing charcoal or sand, which prevents leaves, decayed wood, or other foreign matter, from passing to the cistern. It has a detachable section which intervenes between the conductor and the filter, and has a perforated strainer which arrests leaves and other larger matters which can be removed from time to time by separating the sleeve-joint coupling.

Asbestus has been used for filtering, and has this merit among others, that it may be purified readily by making it red hot.

M. Maurras's filter is a water-tight iron box 5½ feet square, with a filtering surface of 60 superficial feet, which, with a head of 12½ feet, is calculated to filter 150,000 gallons of water per diem. It percolates from the circumference inward, passing through fine and coarse sand, is received in a central chamber from whence it is discharged by a pipe. The chamber contains a number of perforated boxes containing sand which cannot pass the interstices; between these are layers of fine and coarse sand. The reversal of the current agitates the contents so as to stir up the sediment, which passes off to the waste-pipe, till the sand is cleaned. The ordinary flow is then resumed.

The mode of filtration in those of the London Water-Works, wherein this process of purification is used, is by the descent of the water, which passes through strata of fine and coarse river sand, broken shells, and pebbles, small and large gravel. These are placed in the bottom of the reservoir, so as to present an undulated surface. Below these are tunnels made of brick, built open-jointed. The sediment penetrates to a depth of from 6 to 9 inches, and that much of the surface-sand is frequently removed, portions of the area at a time. An acre of area filters 300,000 to 400,000 cubic feet daily.

A natural filter is used at Nottingham, England, the reservoir being dug in such position as to receive its water by percolation from the river through a bed of fine sand, which intervenes between the two. The sedimentary matter is continually washed away from the river face of the filter by the action of the stream.

The filter of Greenock, Scotland, is a tank 50 feet long, 12 wide, and 8 deep. The water percolates either upward or downward through the filtering material as it may be directed. After the filter has become foul, by opening a sluice the water is turned in the other direction, passing upward through the filter, and passing off by a waste-sluice. After the water is cleansed, the sluices are changed and the filter operates as before. There are three of these filters in the works.

The filter of Paisley (*c*, Fig. 1974), constructed by Thom, is upon the principle just stated. Water is admitted to the filter by opening a sluice, and runs upon the surface of the filtering material through which it percolates, and passes off by the main. The stop-cock is kept closed so long as the filter does effective duty, but when it becomes choked by sedimentary matter and mud, the stop-valve of the main is closed, the stop-cock lowered, and the water carried by a pipe *beneath* the filtering material, so that the upward pressure will dislodge the mud and carry it up through the various strata of gravel and sand.

Upon the floor of the filter bricks are laid edgeways, a little apart from each other at all points; upon these perforated tiles are laid, nearly touching. The strata of filtering material are successively, —

Gravel, about $\frac{3}{16}$ inch in diameter.

Gravel and sand, four courses of gradually increasing fineness.

Sand, fine, clean, and sharp, 2 feet deep. The upper 6 or 8 inches mixed with broken animal charcoal; say pieces $\frac{1}{16}$ inch in diameter.

When cleaning the filter bed by the upward pressure of water, the upper part of the stratum of sand is raked to dislodge the mud, which is apt to accumulate at the surface.

The filter-bed is 60 × 100 feet in area, divided into three compartments capable of separate use. It is made in a level piece of ground excavated to the depth of 6 to 8 feet, and lined on sides and bottom with a wall puddled in the rear, and laid in hydraulic cement.

The water filtered amounts to 106,632 cubic feet in twenty-four hours.

Natural filters consisting of beds of gravel or sand intervening between a pumping well and a muddy river or sea water, as the case may be, are found in many places; Dayton, Ohio, and Cape Cod may be mentioned, in addition to that at Nottingham, England, just cited.

The filter for sirups is charged with bone-black, revived from time to time by reburning to consume the absorbed organic matter. As a mere filter, cloth covered with paper pulp has been used successfully for sirups. See SUGAR-FILTER; CENTRIFUGAL-MACHINE.

The filter for separating the mucilaginous matters from vinegar is charged with wood-shavings, straw, spent tan-bark or *rapes*. The latter consists of stalks and skins of grapes from which the must has been expressed. *Rapes* are far preferable to any other material. The vinegar is passed again and again through the filter.

Air-filters are used for arresting dust, steel-filings, smoke, etc., according to circumstances and exposure. (See AIR-FILTER.) A filter recommended by Professor Tyndall consists of a cylinder four or five inches long and two inches or more in diameter. Its interior contains, at the top, a layer of cotton-wool which has been moistened with glycerine, then a layer of dry cotton-wool, then a layer of charcoal, then cotton-wool, with wire-gauze covers at both ends, and at the upper end a mouth-piece so shaped as to fit closely over the mouth of the wearer. By drawing the breath through this instrument, the most dense smoke may be entered with impunity. When places are to be entered, such as mines or wells, where carbonic-acid gas is present, it is necessary to add another layer of cotton-wool, and to place between the two bottom layers of cotton a layer of slaked lime to arrest moisture and carbonic-acid gas. See also INHALER; RESPIRATOR.

See under the following heads: —

Air-filter.	Laboratory-instruments.
Air-pressure filter.	Oil-filter.
Bag-filter.	Petroleum-filter.
Bent-pipe filter.	Physeter.
Capillary-filter.	Pressure-filter.
Centrifugal-filter.	Rape.
Charcoal-filter.	Reversible filter.
Cistern-filter.	Sponge-filter.
Drip-stone.	Stoneware-filter.
Faucet-filter.	Strainer.
Filter-bed.	Sugar-drainer.
Filtering hydrant.	Sugar-filter.
Filtering-paper.	Tube-filter.
Filtering-press.	Upward-filter.
Globe-filter.	Vacuum-filter.
Hippocrates-sleeve.	Well-tube filter.
Hydro-extractor.	

Fil′ter-bed. A settling pond whose bottom is a filter. It may consist of a reservoir 5 feet deep with a paved bottom covered with open-jointed tubular drains leading into a central conduit. The drains are covered with a layer of gravel and a top layer of sand. The water is delivered upon the surface uniformly, and the rate of subsidence is about six inches an hour. The more rapid the rate (other things being equal) the less effective is the operation. See FILTER.

Fil′ter-fau′cet. One having a chamber containing sand, sponge, or other material to arrest impurities in water.

Fil′ter-ing Ba′sin or Tank. (*Hydraulic Engineering.*) The chamber in which the water from the reservoir of water-works is received and filtered previous to entering the mains. See FILTER.

Fil′ter-ing-hy′drant. One which subjects the water from the service-pipe and main to the action of a material to arrest mud.

Fil′ter-ing-pa′per. A bibulous, unsized paper, thick and woolly in texture, used for filtering solutions in the pharmacy or laboratory. Swedish filtering-paper is thinner and of superior quality.

Fil′ter-ing-press. One in which the passage of a liquid through a body of filtering material is expedited by pressure applied thereto. A *pressure-filter.*

Fin. 1. A mark or ridge left in casting at the junction of the parts of the mold.

2. A slip inserted longitudinally into a shaft or arbor, and left projecting so as to form a guide for

an object which may slip thereon, but not rotate. A *spline* or *feather*.

3. A tongue on the edge of a board.

Find'er. (*Optics.*) A small telescope fixed to the tube of a larger one, the axes of the two instruments being parallel. The *finder* has a larger field of view than the principal instrument, and its purpose is to find an object towards which it is desired to direct the larger telescope.

Fine-arch. (*Glass.*) The smaller fritting-furnace of a glass-house.

Fine-arts. So far as this subject is considered in this work, it may be found under the following heads: —

Albertype.
Anaglyptography.
Anastatic-printing.
Aquatint.
Autopyrography.
Autotype.
Bank-note.
Bantam-work.
Basso-rilievo.
Block-printing.
Bronzing.
Buhl.
Burin.
Bust.
Calico-printing.
Calking.
Calotype.
Calquing.
Camaieu.
Cameo.
Camera.
Canvas-stretcher.
Carbon-printing.
Cartoon.
Chalcography.
Chasing.
Chemitype.
Chiaro-oscuro.
Chromatic-printing.
Chromo-lithography.
Chromo-xylography.
Cliché.
Crystallo-engraving.
Crystallo-ceramic.
Copperplate-engraving.
Cradle.
Crayon.
Cycloidal-engine.
Dab.
Daguerreotype.
Dead-coloring.
Deadening.
Demi-relief.
Demi-tint.
Distemper.
Diamond-point.
Die-sinking.
Easel.
Electypography.
Electrotint.
Elydoric-painting.
Embossing.
Embroidery.
Enameling.
Enamel-painting.
Encaustic-painting.
Enchasing.
Engraving.
Engraving-tools.
Etching.
Flatting.
Fresco.
Galvanoglyphy.
Galvanography.
Gelatine process.
Gem-engraving.
Gilding.
Glass.
Glass-coloring.
Glass-enameling.
Glyphograph.
Glyptograph.
Graining.
'Graph (see list under this head).
Graver.
Gumming.
Hair-pencil.
Half-relief.
Hatching.
Head-rest.
Heliograph.
Heliotype.
High-relief.
Inlaying.
Intaglio.
Japanning.
Lay-figure.
Lithography.
Lithophotography.
Lithotint.
Lithotype.
Low-relief.
Marquetry.
Mat.
Maul-stick.
Medal.
Medal-machine.
Medallic-engraving.
Metallo-chrome.
Metallography.
Mezzo-relievo.
Mezzotint-engraving.
Miniature.
Monogram.
Mosaic.
Nature-printing.
Negative.
Niello.
Palette.
Paneiconograph.
Panorama.
Parian.
Parquetry.
Passe-partout.
Pastel.
Pencil.
Photogalvanograph.
Photograph.
Photograph-cutter.
Photographic-apparatus.
Photographic-camera.
Photographic-engraving.
Photographometer.
Photolithograph.
Photosculpture.
Photozincograph.
Piqué-work.
Plaster-cast.
Plate-holder.
Polychrome.
Pottery-painting.
Print-holder.
Printing-frame.
Pyrograph.
Reisner-work.
Relief.
Relief-line engraving.
Rilievo.
Scribbet.
Sculpture.
Scumbling.
Sepia.
Silhouette.
Statuary casting.
Statue.
Statuette.
Stencil.
Stereochromy.
Stereograph.
Stereoscope.
Stretcher.
Stump.
Vignette.
Wax-modeling.
Xylograph.
Xylopyrography.
Zincography.

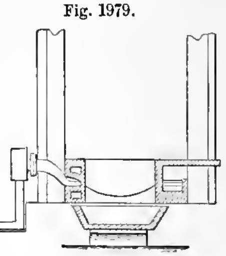
Fine-draw'ing. A finishing process with cloth in which it is subject to a strong light while all faulty parts or breaks in the fabric are closed by sound yarn introduced by a needle.

Fine-nail. A name used in some trades to distinguish a relatively thin from a coarse nail, such as a fencing nail or clout. A *finishing* nail.

Fine'ness. The quantity of pure metal in an alloy expressed in 1,000 parts; as the fineness of United States coin is 900, the other 100 being alloy.

Fin'er-y-fur'nace. A species of forge-hearth in which gray cast-iron is smelted by fuel and blast, and from which it is run into iron troughs for sudden congelation. The result is a finer quality of cast-iron of whiter color, which is subsequently puddled and made malleable. The furnace is of brick with hollow iron lining, through which water circulates. The fuel is coke or charcoal, and the melted metal is run from the crucible into a pit, where it is quenched with water to render it brittle, and perhaps oxidize it somewhat.

Fig. 1979.



Finery-Furnace.

Fine-stuff. Lump lime slaked to a paste with a moderate volume of water, and afterward diluted to the consistency of cream, and then left to harden by evaporation to the required consistency for working over a floating-coat of coarse-stuff.

In this state it is used for a *slipped-coat*, and when mixed with sand or plaster-of-paris it is used for the *finishing-coat*.

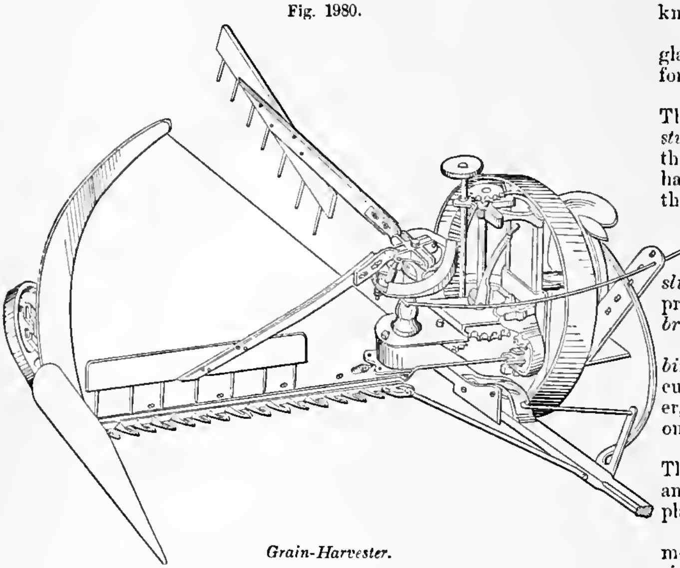
Fin'ger. 1. (*Machinery.*) *a.* A small projecting rod or wire, which is brought into contact with an object to effect or restrain a motion. The derivation of the name from the human finger is apparent, and the action is sometimes marvelously similar; as in the delicate pieces of tactile and prehensile mechanism in the stop-motions of machines working in fiber. Known as a gripper in printing-machinery.

b. One of a row of similar projections, as the finger of a rake. Sometimes, as in the example, synonymous with *tooth*.

2. (*Husbandry.*) One of the projecting pieces on a finger-bar of a harvester, within and against which the knives play. See FINGER-BAR.

Fin'ger-bar. (*Agriculture.*) The bar of a reaping or mowing machine, whose front edge has projecting fingers, called *guards*, through whose horizontal slots the serrated knife reciprocates. (See GUARD.) Moving in either direction, the knife sections make a shear cut against the sharp edges of the guards, so as to sever the stalks of grain or grass which are divided either way by the guards, which hold the stalks laterally as the knives make their draw-cuts against the stems. The illustration shows the finger-bar in its relation to the quandrantal platform, revolving-rakes and driving and supporting mechanism.

Fig. 1980.



Grain-Harvester.

Fin'ger-board. The neck of a stringed instrument of the viol, banjo, or guitar class, on which the strings are pressed by the fingers in playing.

Fin'ger-grip. (*Well-boring.*) A tool for recovering rods or tools dropped into a bored shaft. It consists of a rod having a foot which is twisted around so as to penetrate beneath the object and enable it to be lifted and withdrawn. See GRAB.

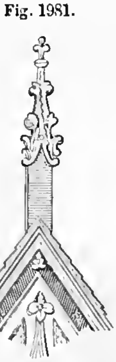
Fin'ger-nut. A nut with wings to afford a hold.

Fin'ger-plate. A plate on the side of a door, near the edge, to keep finger-marks from the paint.

Fing'roms. (*Fabric.*) Cloth made of *combed* wool.

Fin'i-al. A pointed ornament or pinnacle surmounting the apex of a Gothic gable.

Fig. 1981.



Finial.

Specifically, a bunch of foliage which terminates pinnacles, canopies, pediments, etc., in Gothic architecture.

Fin'ing. 1. Material used to add to a turbid liquid to clear it. As the isinglass or albumen subsides in the liquor, it carries down the particles mechanically suspended therein. In this way, wine, cider, sirups, and many solutions are cleared.

2. (*Metallurgy.*) Treatment of metal to remove impurities and foreign matters, as the fining (refining) of cast-iron to convert it to malleable iron by the removal of the carbon, etc.

Fin'ing-forge. (*Metallurgy.*) An open hearth with a blast by which iron is freed of impurities or foreign matters. Cast-iron is thus rendered malleable. See Fig. 1979.

Fin'ing-pot. (*Metallurgy.*) A crucible in which metals are refined.

Fin'ing-roll'er. (*Paper-making.*) A cylindrical wire-cloth sieve in the paper-making machine, which allows the finely ground stuff to pass, but restrains the coarse fibers and knots.

Fin'ings. A solution of isinglass, gelatine, or white of egg, for clarifying liquids.

Fin'ish-er. 1. (*Paper-making.*) The second *beating-engine*, or *half-stuff engine*, which operates upon the partially worked rags that have been previously reduced in the *stuff-engine* and then bleached.

2. The final carding-machine, which perfects the *fleece* or delivers the *sliver;* as distinguished from the prior machine, known as the *breaker*. A *finishing-card.*

Fin'ish-er's Press. (*Bookbinding.*) A small press, like a cutting-press, used by the finisher, who does the ornamental work on the cover.

Fin'ish-ing. 1. (*Engraving.*) The work of the graver, dry-point, and machine-ruler upon an etched plate.

2. (*Bookbinding.*) The ornamental work on a book after it is simply covered with leather or cloth, which is known as *forwarding.*

The term has many applications in the useful and ornamental arts, when a second set of workmen take up and *finish* a work which is systematically passed through a series of hands in regular order of time.

Fin'ish-ing-card. A machine in which the process of carding is repeated. The machine which first operates upon the material is known as the *breaker-card*. See CARDING-MACHINE.

Fin'ish-ing-coat. (*Plastering.*) The third coat on the better style of work. For painting, it consists of the best stuff, and is called *stucco*. For paper, it consists of the same as the previous coat, and is called *setting.*

Fin'ish-ing-ham'mer. The last hammer used by the gold-beater. The series is as follows: —

The *flat* or *enlarging hammer;* the *commencing*-hammer; the *spreading*-hammer; the *finishing*-hammer.

The latter has a more convex face than either of its predecessors; it has a face 4 inches diameter, and weighs 13 or 14 pounds. See GOLD-BEATING.

Fin'ish-ing-rolls. A second set of rolls in a rolling-mill. The first set is the *roughing-rolls*, which operate on the bloom from the tilt-hammer or squeezer and reduce it to *bar* form. This is then cut up, piled, reheated, and taken to the finishing-rolls, which make it into bar or rod iron. The reheating purifies, and the second rolling improves the tenacity by the repetition of the drawing. The finishing-rolls run at a speed two or three times greater than the roughing-rolls, according to size.

Fire-a-larm'. An automatic arrangement by which notice of fire is given. It depends for its action upon the increased temperature of the air in the vicinity of the fire, or upon the burning away of certain connecting cords which are stretched in exposed situations.

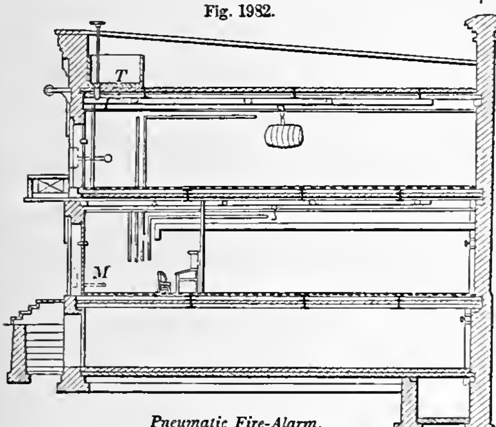
Some of these alarms are designed to give audible notice in a central situation, say at a police or fire-alarm telegraph station, the office of a warehouse or store, the bedroom of a dwelling, the cabin of a vessel. Others, in addition to the said notice, turn on a body of water to the floor whence the notice has come, or break a bottle of acid to liberate carbonic-acid gas in a reservoir of chemicals previously prepared.

a. That form of fire-alarm which depended upon the burning away of hempen springs to give the alarm, was patented in England by Joseph Smith, 1802. Cords are stretched through various rooms in the house, and connect with an alarm apparatus in the office or the bedroom of the person in charge. The cords are saturated with inflammable material, which assists in their combustion when the fire reaches them, and the breaking of either causes its alarm-weight to fall.

b. Another kind of fire-alarm has tubes throughout the building. The tubes proceed from each floor and apartment to a central office, and the occurrence of fire in either causes an expansion of air which is evidenced by a blast of air from the tube.

In the example, a farther arrangement is made, by which from the office *M* a stream of water from a

Fig. 1982.



Pneumatic Fire-Alarm.

tank *T* on the roof may be turned on to the floor when the alarm has been transmitted.

c. The increased heat of the apartment causes expansion of a body of mercury, and brings it in contact with a wire of a metal which readily amalgamates. The wire then breaks with the strain applied to it. The fracture of the wire releases the escapement of the clock-work, and the hammer strikes the alarm-bell. The same automatic agency turns a cock and admits an extinguishing agent which is kept in reserve.

d. A thermostatic arrangement by which a closure of an electric circuit is made when the metal expands under the increment of heat. The thermostat is a column of mercury, which ascends in a tube and makes the electric connection ; or a plate or coil of two metals on the principle of the chronometer-balance, or it is an elongating rod.

The connection made, an armature in the telegraphic-wire circuit is attracted by its magnet and releases a clock-work alarm.

The Tunnicliffe fire-alarm has a cylindrical barrel 3 inches long by 1½ inches in diameter, which, by a screw attached midway along its length, may be readily secured to the ceiling or any part of the room desired. It contains, when ready for use, a small charge of powder, to which is attached an inch of fuse. This fuse is formed of a chemical mixture that will ignite whenever the surrounding atmosphere is heated to 200° F. In case of fire, the heat which ascends to the ceiling quickly ignites the fuse and causes an explosion sufficiently loud to be heard all over an ordinary four-story building. The alarms can be so arranged as to ring bells in any desired room in the building where placed, and may be attached to wires connected with burglar-alarms in stores and residences.

Fire-a-larm' Tel'e-graph. The name applied to the system of telegraphy usually adopted in this country for giving notice of fires.

The first practical applications of the telegraph to this purpose were in 1851 in the cities of New York and Berlin, that in the latter under charge of one of the Siemens brothers. These systems simply connected a series of watch-towers, wherein watchmen were stationed, by an ordinary Morse line, so that the watchmen could telegraph to each other the locality of a fire.

The present system is that of Farmer and Channing, American patent of May 19, 1857.

Mr. Channing first devoted his attention to this subject in 1845, and published several articles that year attempting to show its feasibility. In 1848, Mr. M. G. Farmer invented a method of ringing bells by electricity, and in an experimental trial that year the bell in the tower of Boston City Hall was rung by an operator in New York.

In 1851, Boston appropriated money to build a fire-alarm telegraph, and early in 1852 the line was completed, put in operation, and proved a success.

That system is still in use, the improvements being in the mechanical devices for carrying it into effect.

It comprised a central station, a series of signal-boxes at suitable intervals over the city connected in one or more circuits to the central station, and a series of alarm-bells connected to the central office on another circuit.

The signal-boxes contained a circuit-breaking wheel, having upon its periphery cogs or teeth, upon which a spring, pressing, closed the circuit. These cogs or teeth and their interdental spaces were so arranged on each wheel that, when the wheel was revolved by hand, the circuit was made and broken, to indicate the number given to the box making the signal. This number, being received at a central station, was immediately transmitted on the bell-circuit, bells being struck so as to indicate the box from which the alarm originated.

In the original boxes the circuit-wheel was turned by hand ; in the later boxes the wheel is turned by clock-work driven by a spring. In lieu of an operator at the central station, a repeater is there used, the alarm from the box-circuit being automatically repeated thereby upon the bell-circuit. Sometimes the bells and boxes are united in one circuit, so that from a box the general alarm is directly given. These modifications constitute what is known as the "Farmer and Channing improved" or "automatic system," from the fact that no operators at all are necessary, the turning in of an alarm at any station setting in motion all the machinery of the system.

William B. Watkins, in his patents of January 31, 1871, has extended the system so that fire or the operations of burglars automatically give an alarm at a central station. In each house (and each room, if desired) thermostats, composed of metallic strips, are so arranged as to close the circuit of a local line upon a certain elevation of temperature, expanding the strips. Such closing actuates a local magnet, whose armature releases a detent of the signal-box mechanism, allowing the signal-box in main circuit to send in the alarm. On the same local circuit are also arranged burglar-detectors, so that a door or window being opened closes the local circuit with the same result.

Fire-an-ni'hi-la'tor. Invented by Phillips in 1849. A vessel is charged with a mixture of dried ferro-cyanide of potassium, sugar, and chlorate of potassa. It is set in action by a blow on a glass bottle which contains sulphuric acid, which flows over the charge and liberates gas which is emitted at a nozzle and expended upon a fire to quench it. See FIRE-EXTINGUISHER.

Fire-arm. A weapon which projects a missile by the explosion of gunpowder. It succeeded the long and cross bows, but the periods of the two weapons in Europe lapped upon each other. (See ARROW; BOW.) The bow and arrow are yet used by millions in Asia, Africa, and America, but the owners are always glad to trade for muskets and rifles.

The first fire-arms were doubtless rockets, in which the force of the explosion carried the tube. To these probably succeeded something of the nature of the fire-works known as Roman candles, in which pellets are loaded into a tube and fired by a match at the tube-mouth. The tubes were of bamboo, paper, or cloth, probably each of these, according to circumstances. (For early notices, see GUNPOWDER.) The cracker was used as a grenade anciently in China, and in the 8th century by the Greeks.

The first fire-arms used in Europe were cannon. (See ARTILLERY; CANNON.) Fire-arms to be carried by the soldier were a later invention. The *arquebus* was used in 1480. The musket by Charles V. in 1540. These used matches or match-locks. The wheel-lock was invented 1517; the flint-lock about 1692. The percussion principle by the Rev. Mr. Forsythe, in 1807. See GUN-LOCK.

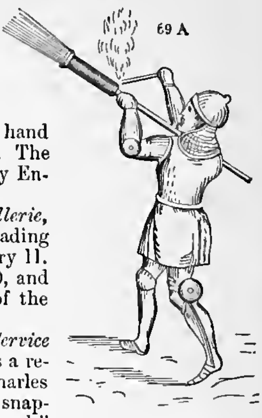
For varieties, see under the following heads: —

Accelerator.	Gatling-gun.
Armstrong-gun.	Gun.
Arquebus.	Howitzer.
Barbette-gun.	Jingal.
Battery-gun.	Lancaster-gun.
Birding-piece.	Magazine fire-arm.
Blunderbuss.	Mitrailleur.
Bombard.	Mortar.
Breech-loader.	Musket.
Byssa.	Musketoon.
Calabass.	Needle-gun.
Cannon.	Ordnance.
Carbine.	Parrot-gun.
Carronade.	Pistol.
Casemate-gun.	Pistol-carbine.
Chassepot-gun.	Pivot-gun.
Coehorn.	Repeating fire-arm.
Columbiad.	Revolver.
Culverin.	Rifle.
Dahlgren-gun.	Shot-gun.
Double-barreled gun.	Shunt-gun.
Enfield-rifle.	Si ge-gun.
Eprouvette.	Small-arm.
Field-gun.	Swivel-gun.
Fowling-piece.	Tinker.
Fusil.	Whitworth-gun.

This article treats of breech-loading small-arms generally; *magazine fire-arms, needle-guns, revolvers, pistols, cannon,* and *battery-guns* are also considered under their respective heads.

"It was in 1430," says Biblius, "that small-arms were contrived by the Lucquese, when they were besieged by the Florentines." A French translation of Quintius Curtius, preserved in the British Museum, has the earliest illustration of hand fire-arms yet discovered. The cut is from the "Penny Encyclopædia."

Fig. 1983.



Fire-Arm of the Fifteenth Century.

In the *Musée d'Artillerie*, Paris, is a breech-loading arm of the time of Henry II. of France, prior to 1550, and a match-lock revolver of the same period.

In the *United Service Museum*, of London, is a revolver of the time of Charles I. It is called "a snaphaunce self-loading petronel." It has a revolving cylinder containing seven chambers with touch-holes. The action of lifting the hammer causes the cylinder to revolve, and a fresh chamber is brought into connection with the barrel. Six of the seven chambers are exposed to view, and the charges are inserted without the aid of a ramrod.

Speaking generally, the early hand-guns were breech-loaders. See REVOLVER.

Abraham Hall's English patent, 1664, had "a hole at the upper end of the breech to receive the charge, which hole is opened or stopped by a piece of iron or steel that lies along the side of the piece, and movable by a ready and easy motion."

Henry VIII. took much interest in fire-arms, and two weapons, yet extant, manufactured during his reign, were substantially the same as the modern Snider rifle.

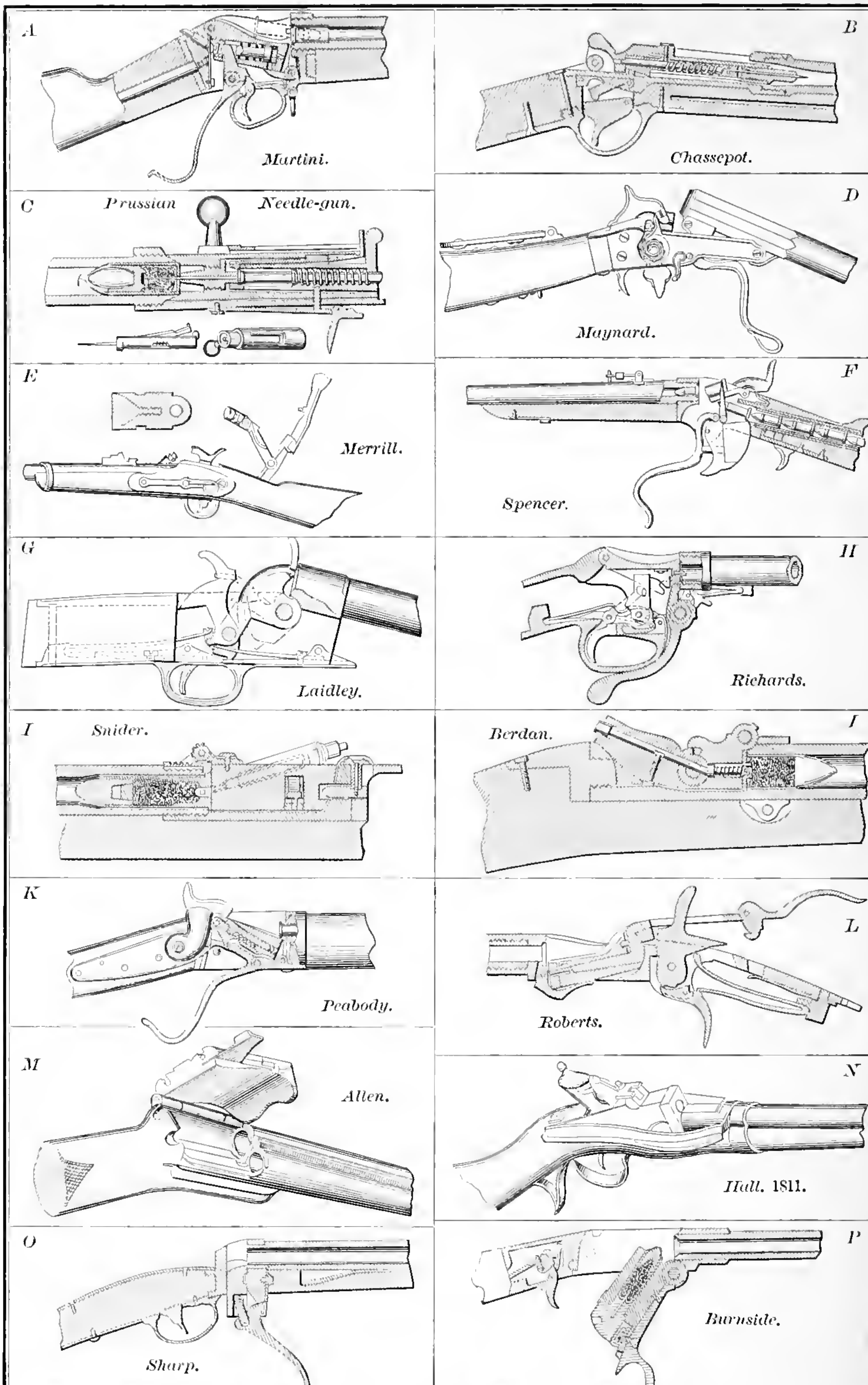
Among the curiosities of this branch of invention is Puckle's English patent, No. 418, May 15, 1718. The accompanying illustration is from the original drawing attached to the patent, and the description following is that filed by the inventor.

"A DEFENCE.

Defending KING GEORGE, *your* COUNTRY *and* LAWES
Is defending YOURSELVES *and* PROTESTANT CAUSE.

A Portable Gun or Machine, called a Defence. For Bridges, Breaches, Lines, and Passes, Ships, Boats, Houses, and other Places.

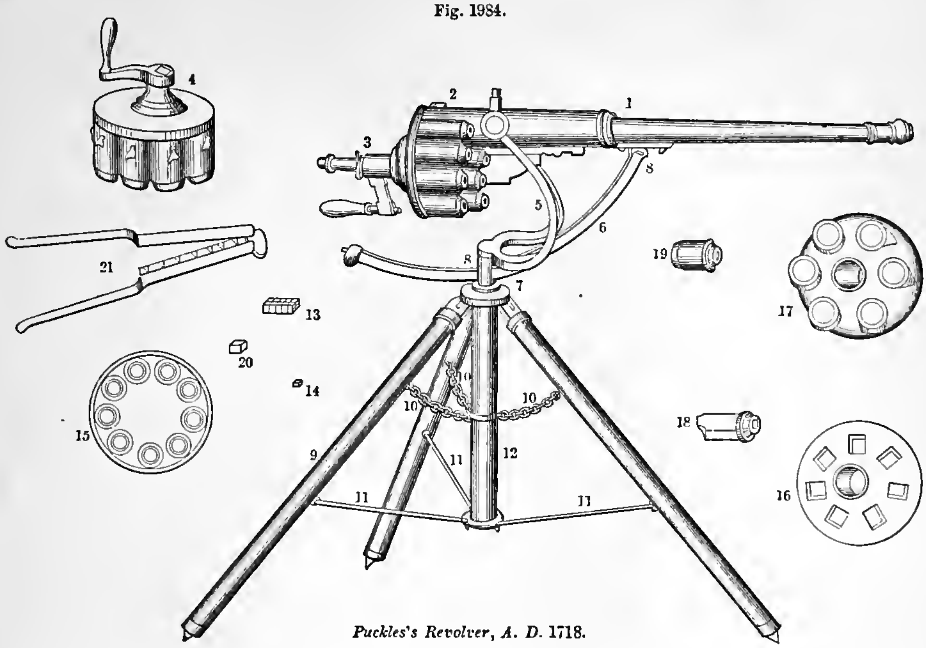
No. 1. The barrel of the gun.
2. The sett of chambers charg'd put on ready for fireing.
3. The screw upon which every sett of chambers play off and on.
4. A sett of chambers ready charg'd to be slip'd on when the first sett are pull'd off to be re-charg'd.
5. The crane to rise fall and turn the gun round.
6. The curb to level and fix the guns.
7. The screw to rise and fall it.
8. The screw to take out the crane when the gun with the trepeid is to be folded up.
9. The trepeid whereon it plays.
10. The chain to prevent the trepeids extending too far out.
11. The hooks to fix the trepeid, and unhook when the same is folded up in order to be carried with the gun upon a man's shoulder.



BREECH-LOADING FIRE-ARMS.

PLATE XVI. *(American and European.)* *See page 851.*

Fig. 1984.



Puckles's Revolver, A. D. 1718.

No. 12. The tube wherein the pivot of the crane turns.
13. A charge of twenty square bullets.
14. A single bullet.
15. The front of the chambers of a gun for a boat.
16. The plate of the chambers for a gun for a ship, shooting square bullets against Turks.
17. For round bullets against Christians.
18. A single square chamber.
19. A single round chamber.
20. A single bullet for a boat.
21. The mold for casting single bullets."

The parts of a gun are: —

Ante-chamber; the cavity which connects the hollow of the nipple with the chamber in the breech.

Barrel; the tube out of which the load is discharged.

Bead; the silver knob for sighting on the end of the barrel.

Bolt; the sliding piece which secures the barrel to the stock.

Breech; the piece containing the chamber which screws into the barrel.

Butt; the broad end of the stock which is placed to the shoulder.

Cap; the brass tube which incloses the worm of the ramrod.

Chamber; the cavity of the breech in which the powder is deposited and exploded.

False-breech; the iron piece on the gun-stock which receives the breech-claws, and assists in holding the barrel firmly to the stock.

Guard; the metallic scroll which defends the triggers.

Heel-plate; the plate on the butt.

Lock; the piece of many parts by which the gun is fired. See GUN-LOCK.

Loop; the clasp on the barrel through which the bolt passes and secures it to the stock.

Nipple; the tube on which the cap is placed, and through which the powder reaches the charge.

Nipple or *cone wrench;* a small turning tool for securing or loosening the nipple, to and from the barrel.

Pipes; short tubes which hold the ramrod to the barrel.

Rib (upper and under); the center-piece which unites the barrels.

Side-nail; the screw which fastens the lock to the barrel.

Sight (breech and muzzle); an object or depression on the breech, a bead or knob on the muzzle, by bringing which into line with the object the line of fire is directed.

Trigger-plate; the iron plate in which the triggers work.

Worm; the screw at the end of the ramrod.

Of the gun-lock the parts are the

Bridle.	Sear-spring.
Chain, or swivel.	Spring-cramp.
Cock, or hammer.	Trigger.
Lock-plate.	Tumbler.
Main-spring.	Tumbler-screw.
Sear.	See GUN-LOCK.

The first patent in the United States for a breech-loading fire-arm was to Thornton and Hall of North Yarmouth, Mass., May 21, 1811. Between that time and 1839 more than 10,000 of these arms were made and were issued to the troops in garrison and on the frontier. This gun is represented at *N*, Plate 16, and had a breech-block, which was hinged on an axial pin at the rear, and tipped upwardly at front to expose the front end of the charge-chamber. The flint-lock and powder-pan were attached to the vibrating breech-block. The arm is shown and described in detail in General Norton's "American Breech-Loading Small-Arms," New York, 1872.

Before the war of 1861 – 65, the principal breech-loading small-arms were Sharps's, Burnside's, Maynard's, Merrill's, and Spencer's.

Sharps's rifle (*O*, Plate 16) has the barrel rigidly attached to the stock, the rear being opened or closed by a vertically sliding breech-block, which slides up and down in a mortise operated by the trigger-guard, which is pivoted at the front end, or by a lever.

The primer consists of small pellets of fulminate inclosed in a copper casing so as to be water-proof. These are placed in a pile in a hole in the lock-plate, forced upward by a spiral spring, the upper one fed forward by a plunger, caught by the cup of the hammer, and carried down upon the nipple. The cartridge is in cloth, the end covered with tissue-paper saturated with saltpeter, through which the fulminate will ignite the powder.

Burnside's rifle (*P*) has the barrel attached to the stock, the breech-piece being pivoted beneath the barrel, so as to swing downward and expose the chamber in the front end of the breech-piece for the insertion of the cartridge.

In Maynard's rifle (*D*) the barrel is pivoted to the front end of the stock, and its rear end tips upwardly, exposing the chamber for the cartridge, when the barrel is tipped down against a solid breech-piece and locked. The Maynard primer consists of pellets of fulminate placed at regular intervals between narrow strips of paper. This is coiled in a chamber in the lock-plate, and is fed forward by a wheel operated by a hammer, so as to bring a pellet on top of the nipple at each discharge.

The Merrill gun (*E*) was constructed for a paper cartridge. The breech was closed by a sliding plug locked in place by a combination of levers. The charge was exploded by a copper cap, placed upon the nipple in the ordinary manner.

The Spencer rifle (*F*) is both a magazine and a single breech-loader, seven cartridges being placed in a magazine in the but, and being thrown forward to the chamber as required. The breech-block is a sector pivoted beneath the level of the barrel, and retreating backward and downward to expose the rear of the bore for the insertion of the cartridge. The trigger-guard forms the lever for moving the breech-block.

The Roberts gun (*L*) has a breech-block pivoted at the rear, operated by a lever which extends backwardly over the small of the stock; the forward end of the breech-block being depressed, the center of its motion and its abutment in firing being a concave solid base centering on the exact prolongation of the axis of the barrel. The breech parts are four in number, articulated without pins or screws. The firing-pin passes centrally through the breech-block, and is driven forward on the center of the cartridge by a blow of the hammer.

The Martini gun (*A*) is the invention of a Swiss. The breech-block is pivoted at its upper rear portion, being moved up and down by a lever at the rear of the trigger-guard. The firing is by a spiral spring, which actuates a firing-pin. The cartridge-shell extractor works on a pivot below and behind, the barrel being operated by the descent of the front end of the breech-block upon one arm of the bell-crank lever.

The Chassepot gun (*B*) is the French arm, and is named after its inventor. It is what we term a bolt-gun, an opening on the right hand of the chamber admitting the insertion of the cartridge. The forward thrust of a knob drives the cartridge into the breech, and a partial rotation of the knob locks the breech-piece. The firing is by a needle.

The Prussian needle-gun (*C*) is also a bolt-gun, having an inner bolt which forms the firing-pin, a sleeve around it, and an outer cylinder. The parts are shown with the needle in its fired position. In preparing to reload, the rear knob is withdrawn, and the axial bolt retained by a catch which engages a projection, withdrawing the needle. The chamber is then unlocked by the knob and slid back, the cartridge inserted and driven into the breech by the chamber, which is locked by a partial rotation. The firing is done by releasing the needle-bolt.

The Laidley gun (*G*) has a breech-block pivoted beneath the barrel and rotating backward and downward to open the chamber. When in position for firing, it is fastened by a locking-brace which is operated by a spring, and vibrates on the same axis as the hammer. The breech-block is unlocked by a cam and thrown back by a pawl attached to the locking-brace and actuated by the hammer.

The Westley-Richards gun (*H*) is an English arm having a pivoted breech-block whose front end is depressed by the action of a lever pivoted to the stock beneath the rear of the barrel.

The Snider gun (*I*), built at Enfield, England, is similar to our Springfield converted rifle, of which presently. The breech-block is hinged to the rear of and above the barrel, the block throwing upward and forward, exposing a chamber in rear of the bore. Into this the cartridge is dropped, pushed into the bore, the block brought down and locked by a latch in the rear. The firing-pin passes obliquely through the block and is struck by the ordinary hammer.

The Berdan form of this type is shown at *J*, and has a breech-block in two sections hinged together.

K is the Peabody gun, which has a falling breech-block, hinged at the rear and depressed by the guard-lever, whose short arm engages in a recess of the block and controls its movements. When the block is down, the cartridge is slipped into the bore, and the piece is fired by the fall of the hammer upon a firing-pin sliding in a groove in the side of the block. In opening to reload, the block drops upon an elbow lever and withdraws the spent cartridge-shell.

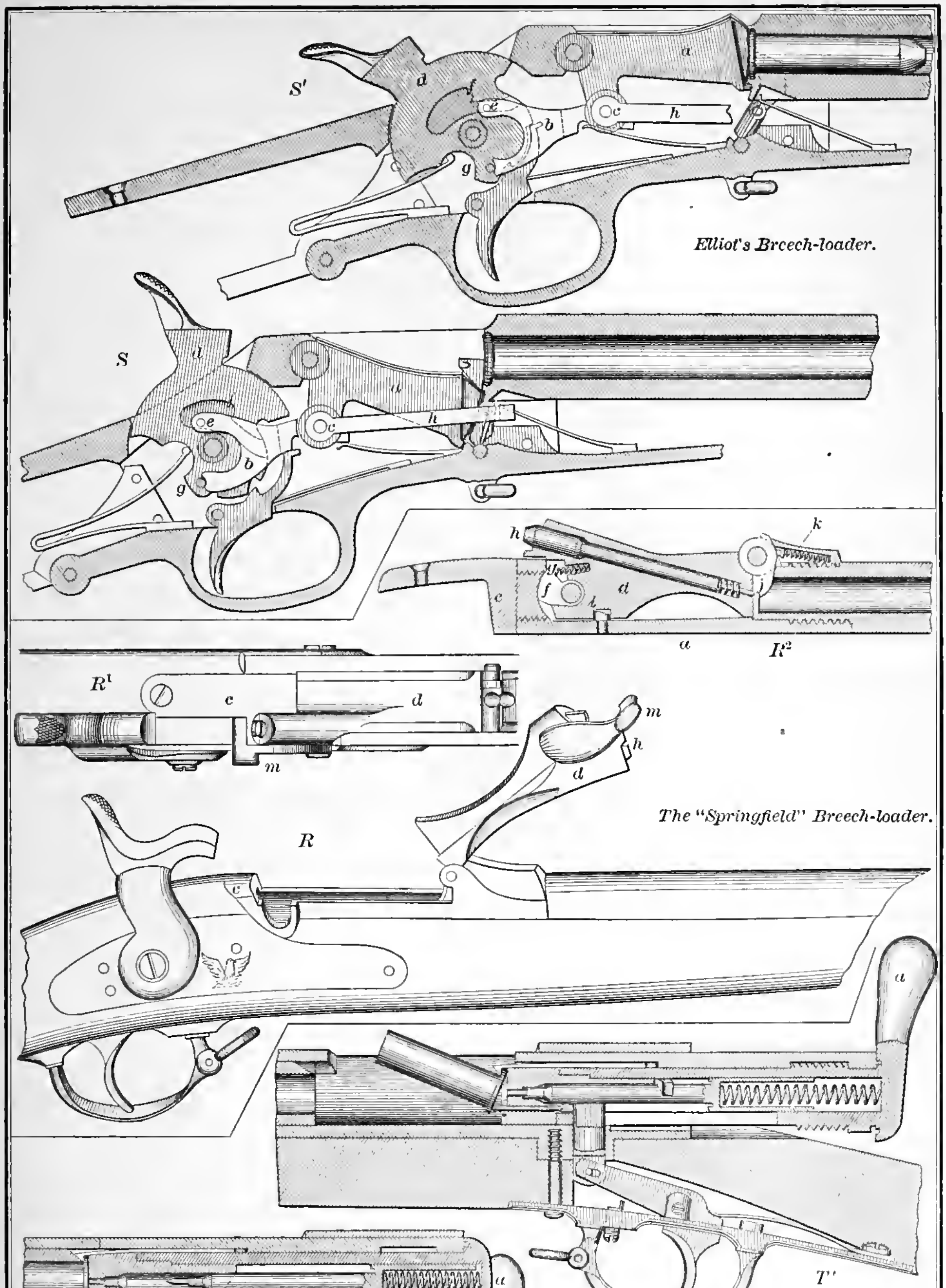
Allen's gun (*M*) is double-barreled, and the breech-block is hinged at the side, swinging upwardly and laterally. It carries both firing-pins, and is locked shut by a latch.

Plate 17 gives views of the three arms recommended this year (1873) by the army commission at Springfield.

R is the Springfield arm, having a breech-block hinged to the upper edge of the barrel and swinging upward and forward. The indorsement of the board, as the best all things considered, entitles it to an honorable place in the series of examples. *R* is a side view of the gun, with the breech-block *d* thrown up; *a* is the bottom of the receiver, *c* the breech-pin, with its circular recess to receive the cam-latch *f*, which locks the breech-block in place; *g* is the cam-latch spring, *h* is the firing-pin, which transmits the blow of the hammer to the priming of the cartridge, and is pressed back by a spiral spring after the delivery of the blow; *j* is the cartridge-shell ejector, *k* its spring; *l* an incline which tips up the ejected shell so as to throw it out of the receiver.

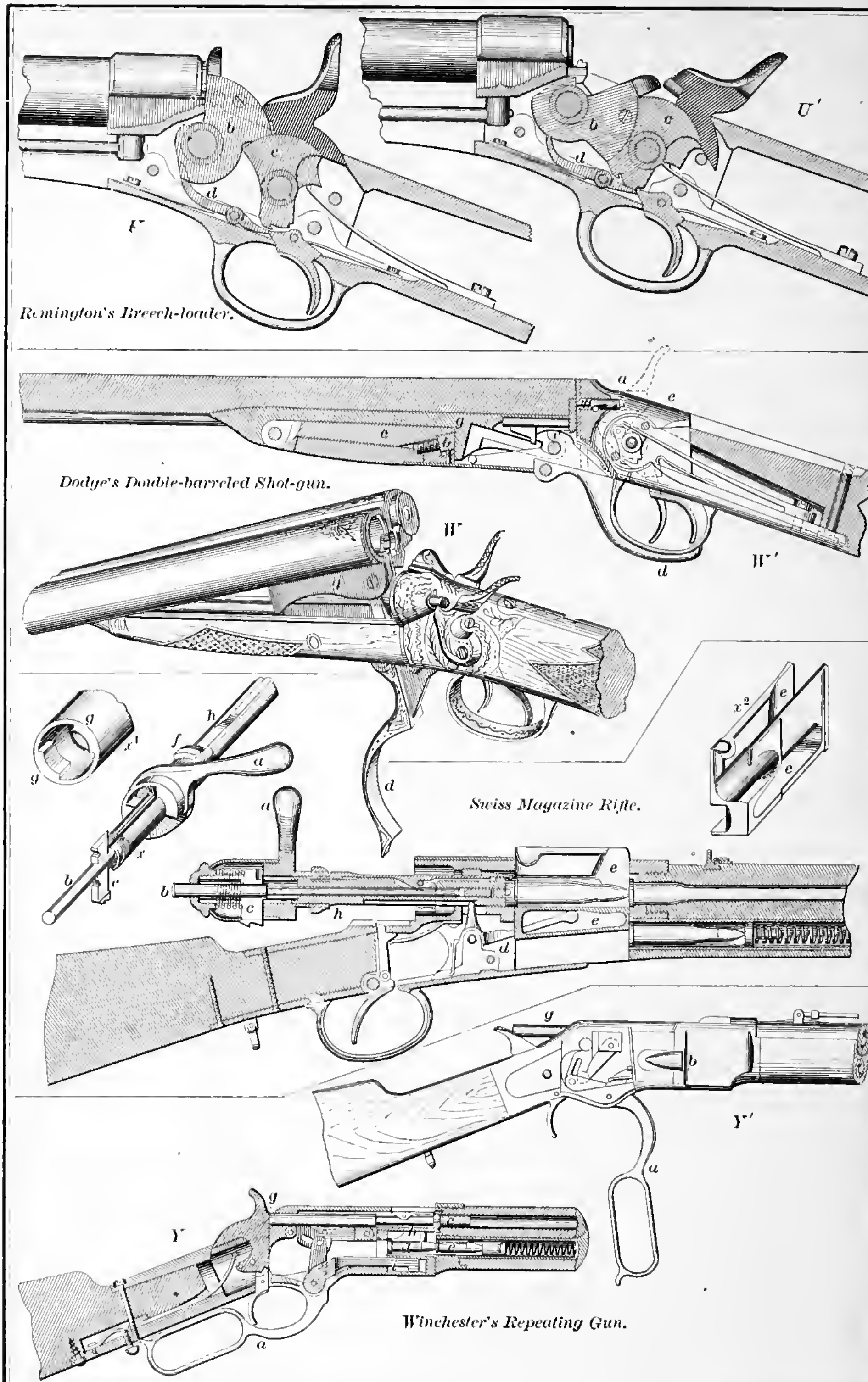
R' is a top view of the gun with block closed. R^2 is a longitudinal vertical section with the breech-block closed. The dotted lines show the block raised.

The breech-block is raised upward and forward in the act of opening by a thumb-piece *m*, which releases it by turning up the cam-latch out of its recess in the breech-pin. When fully open, it discloses the chamber, or rear end of the barrel, ready for the insertion of the charge contained in a copper cartridge-case, holding seventy grains of musket-powder, and firing a bullet $\frac{45}{100}$ of an inch in diameter and weighing about 400 grains. When the breech-block is closed, it is held down and braced against the effort of the heaviest charges by the cam-latch, which flies



BREECH-LOADING FIRE-ARMS.

PLATE XVII (Recommended by the United States Board, 1873.) See page 852.



BREECH-LOADING FIRE-ARMS.

PLATE XVIII

(*American and Swiss.*)

See page 853.

into place in closing. The piece is fired by the ordinary side-lock taken from the old muzzle-loaders. In opening the piece after firing, the breech-block strikes the lump on top of the extractor, and revolves it so as to carry the now empty cartridge-shell to the rear. After passing a certain point, the spiral spring in front of the extractor is released, and accelerates its motion, so that the cartridge is thrown sharply against the beveled surface of the ejector-stud, by which it is deflected upward and expelled from the gun.

S S' are two views of the Elliot carbine recommended by the same board for trial in the field, as exhibiting "remarkable facility of manipulation in requiring but one hand to work it." This arm has a breech-block hinged to the breech-pin and operated by the hammer. Fig. *S* shows the gun in loading position, and *S'* in the position "ready to fire." After firing, the hammer *d* is pulled back to the position shown in *S*, and in so doing draws by the yoke *b* upon the breech-block *a*, to which it is pivoted at *c*. This pulls down the front end of the breech-block, exposing the rear of the barrel for the insertion of the cartridge. Having done this work, the pin *e* of the yoke slips out of the socket *f* into the lower portion of the groove, while the lower branch of the yoke engages over the pin *g*, so that when the hammer is again pulled back, the breech-block is pushed up again into the position shown at *S'*, where the hammer is on full cock and the arm ready to fire. *h* is a strap which works the retractor, so that the shell is ejected as the breech-block is pulled down. *S* shows the cartridge-ejector pulled out; *S'* shows it in its bed. One pull on the hammer depresses the breech-block and ejects the empty shell; another pull closes the breech-block and puts the hammer in position for firing; a pull on the trigger fires the arm.

T T' are two positions of the Ward-Burton gun, which is on the *bolt* principle, like the Prussian needle-gun and the French Chassepot. This gun, in its magazine form, was also recommended "for farther trial in the field." This gun, having been fired, is opened by raising the handle *a* of the bolt and withdrawing it directly rearward; the position is shown in Fig. *T'* of Plate 17. As the cartridge-shell is pulled out by the spring-hook on the upper edge of its flanged rim, the pin which rests against its lower portion comes in contact with the front end of the trigger-pin, which tips it up and throws it out of the receiver. Another cartridge is then introduced by hand or by automatic devices from the magazine, and pushed into the bore of the gun by the longitudinal forward motion of the bolt. Near the head of the bolt is seen a part of the sectional screw which engages with a corresponding section within the gun when the piece is closed, and the handle turned down into place, so as to support the bolt against the force of the discharge. The firing-pin is an axial spring-pin released from the bolt by a downward pull by means of the trigger and lever. Fig. *T* is the position "ready to fire," the driving-spring being condensed and ready to act. Fig. *T'* shows the bolt withdrawn and the cartridge tumbling out. When the bolt is withdrawn, the sleeve of the firing-pin is so far retracted that a shoulder catches behind the trigger. When the bolt is pushed home, driving the cartridge into the barrel, it leaves the shoulder of the firing-pin resting against the trigger, as shown in Fig. *T*.

Plate 18 shows three other American forms of fire-arms, and the Swiss adopted pattern, which is a bolt needle-gun.

U U' are two positions of the Remmington gun; the left-hand figure is "fired," the right-hand "ready to load." The breech-block *b* swings upon a strong pin within a mortise of the stock. *c* is a tumbler which braces the breech-piece against recoil at the time of firing, and forms a part of the hammer which strikes a firing-pin, which passes through the tumbler and is driven against the cap or part of the cartridge-case containing the fulminate.

The breech-piece *b* and tumbler *c* are so formed that when the former is closed the rounded upper portion of the tumbler works in a concavity in the back of the breech-piece, as shown in Fig. *U*, and when the hammer is drawn back to half-cock or full-cock the rounded back of the breech-piece works in a concavity in the front of the tumbler, as shown in Fig. *U'*. This mode of matching the breech-piece and tumbler prevents the possibility of the hammer falling until the breech-piece is perfectly closed, and so obviates the possibility of premature explosion of the charge. The extractor, by which the discharged cartridge-shells are drawn out from the chamber of the barrel, works between the receiver and the breech-piece, and is operated by the opening movement of the latter. The breech-piece is opened by the thumb-piece. A guard-lever *d* prevents the trigger being drawn when the breech-piece is open.

W W' are two views of the Dodge breech-loader, shown as a double-barreled breech-loading fowling-piece. *W* is a perspective view, and *W'* a sectional view. The barrels are hinged to the front end of the stock, so as to tilt upwardly at the rear and nearly balance upon the hinging-point, the motions being made by means of the pivoted lever *d*, which laps over the trigger-guard and locks the barrels in firing position by engagement of a hook c with a pin passing through the lug *g*. The front end of the lever extends beyond the pin on which it turns, and works in a slot in the center of lug *g* beneath the barrels, which it serves to elevate and depress. As the barrels are elevated, the front end of the lever strikes against a projection on the stem of the extractor, and retracts the spent cartridge capsule. The frame *c* is made of a single piece of metal extending from the front, where the barrels are hinged, to the grip in the rear of the breech; and the locks are fitted in recesses therein, dispensing with separate lock-plates. The locks are "rebounding," that is, they go forward and fire the cap and return to half-cock. The hammers draw back the firing-pin when full-cocked. The barrels are adjusted on the frame, and wear is compensated by means of the block *b*. In use, the left hand need not be moved from where it is in firing; the breech is brought under the right arm, the lever thrown down, fresh cartridge inserted, the lever returned, the hammer cocked, and the piece is ready to fire.

The gun adopted by the Swiss Federal government has the magazine and cartridge-carrier of the Winchester, with the needle-exploder and bolt breech. The large figure is a longitudinal central section; *x* is a perspective view of the bolt, firing-pin, and lever detached; x^1 is a view of a piece of th breech-cylinder; x^2 is a view of the cartridge-carrier detached. The motions are as follows: the lever *a* is raised, rotating on the firing-pin *b*, and cocking the latter by the pressure of a cam upon the transverse trigger-bar c; the bolt is then drawn back, carrying the firing-pin and the hook, which retracts the spent cartridge; the motion eventually rocks the bell-crank lever *d* and raises the carrier *e*, which brings another cartridge in line with the barrel. The bolt *h* is then pushed back, pressing down the carrier *e* and driving the cartridge into the barrel; a partial rotation of the bolt, by means of the lever a, locks it firmly by the catching of studs f on the bolt behind lugs g on the breech-cylinder. The firing-pin has remained on cock since the first motion of semi-rotation of the bolt, and is now pulled off by the trigger. The combination is known as Vetterlin's.

Y' is the Henry magazine rifle, now known as the Winchester repeating-gun. It may be used as a single-loader or a repeater. As a repeater, the motion of the lever a withdraws the spent shell of the previous charge, raises the hammer, recharges the gun, and relocks the breech mechanism. The magazine contains seventeen cartridges, which can be discharged in as many seconds. With single loading, the cartridge is placed in the carrier-block, and a single motion puts it in order for firing. The cartridges are placed in the magazine by pressing them through the trap b on the right-hand side of the gun, the magazine being easily filled while the gun swings at the side. They are fed from the magazine into the carrier-block by a spiral spring.

Y is a section of the gun immediately after discharge; e is an empty shell; d one in the carrier-block; e, one in the magazine; by the forward motion of the lever a the links take the position shown in Y', the piston g is withdrawn, raising the hammer to the full-cock, and extracting the empty shell e, which is thrown upward at the same time the carrier-block h with the carriage which it contains is raised by the lever i placing the cartridge opposite the chamber. This position is seen at Y'. The returning motion of the lever drives the piston forward, leaves the hammer at full-cock, forces the cartridge contained in the carrier-block into the chamber, drops the carrier-block to receive the following cartridge from the magazine, and places the arm in readiness to be fired.

The United States has adopted the Springfield.

England adopts Snider's improvement on the Enfield.

France, the Chassepot.
Belgium, the Albini.
Holland, the Snider.
Turkey, the Remington and Winchester.
Austria, the Wanzl.
Sweden, the Hägstrom.
Russia, the Laidley and Berdan.
Switzerland, the Winchester.
Portugal, the Westley-Richards.

Prussia, the needle-gun. The well-known form shown at C, Plate 14, has been superseded by the *Mauser* gun. See NEEDLE-GUN.

The breech-loaders purchased by the American government between January 1, 1861, and January 30, 1866, were of number and kind as follows: —

Ballard	1,500	Maynard	20,002
Ball	1,002	Palmer	1,001
Burnside	55,567	Remington	20,000
Cosmopolitan	9,342	Sharps	80,512
Gallagher	22,728	Smith	30,062
Gibbs	1,052	Spencer	94,156
Hall	3,520	Starr	25,603
Joslyn	11,261	Warner	4,001
Lindner	892	Wesson	151
Merrill	14,495		

CLASSIFICATION OF BREECH-LOADING FIRE-ARMS PATENTED IN THE UNITED STATES.

CLASS A. MOVEMENT OF BARREL.	1. *Sliding longitudinally forward.*	
	2. *Tilting*	(a.) Down at muzzle and up at breech. (b.) With muzzle upward. (c.) On hinged joint.
	3. *Swinging laterally on vertical pin.*	
	4. *Rotating on parallel longitudinal pin.*	
CLASS B. MOVEMENT OF BREECH-BLOCK.	1. *Sliding longitudinally backward*	(a.) Operated by a lever. (b.) Withdrawn by hand by a thumb or spring catch, or by a handle, and fastened by a bayonet-catch.
	2. *Swinging or tilting*	(a.) Hinged to top of barrel and turning upward and forward. (b.) Hinged to side of barrel and swinging laterally forward. (c.) Hinged beneath barrel and swinging forward and downward through mortise. (d.) Swinging on centers or trunnions. (e.) Hinged at rear, to swing upward and backward. (f.) Hinged at rear and swinging laterally. (g.) Hinged at rear and swinging downward and backward through mortise.
	3. *Sliding transversely through mortise*	(a.) Moving vertically. (b.) Moving laterally.
	4. *Swinging or rotating laterally*	(a.) On a longitudinal pin or hinge. (b.) Having the form of a rotating sleeve.
	5. *In form of a faucet or spigot*	(a.) Having chamber in the faucet. (b.) Having chamber in the barrel in front of faucet.
CLASS C. REVOLVERS.	1. *Chambered cylinder revolving on parallel axis*	(a.) Behind a barrel; cylinder charged in front. (b.) Behind a barrel; cylinder charged at rear. (c.) Cylinder without other barrel ("pepper-box").
	2. *Chambered cylinder revolving on vertical axis, behind a barrel.*	
	3. *Chambered cylinder revolving on horizontal transverse axis, behind a barrel.*	
	4. *Revolving hammer acting on several stationary barrels.*	

CLASSIFIED LIST OF BREECH-LOADING FIRE-ARMS PATENTED IN THE UNITED STATES.

[The star (*) designates magazine-guns.]

Class A. — Barrels moving with Relation to the Stock or Breech.

1. *Sliding Longitudinally Forward.*

No.	Name.	Date.
8,690	C. V. Nickerson	Jan. 27, 1852.
14,253	Robertson and Simpson	Feb. 12, 1856.
16 288	Schroeder, Salewski, and Schmidt	Dec 23, "
17,644	G. Smith	June 23, 1857.
17,915	T. Buckman	Aug. 4, "
23,505	T. E. Shull	Apr. 5, 1859.
24,437	T. Bailey	June 14, "
24,936	A. V. Hill	Aug 2, "
28,460	W. H. Elliot	May 29, 1860.
31,809	E. Lefaucheur	Mar. 26, 1861.
32,421	A. V. Hill	May 8, "
32,790	C. Sharps	July 9, "
34,561	W. H. Brown	Mar. 4, 1862
43,284	F Beals	June 28, 1864.
*45,638	R. Roberts	Dec. 27, "
46,207	F. Beals	Feb. 7, 1865.
*46,286	H. F. Wheeler	Feb. 7, "
51,837	B. F. Joslyn	Jan. 2, 1866.
52,258	F. Beals	Jan. 30, "
58,525	D. Williamson	Oct. 2, "
65,704	R. E. Stephens	June 11, 1867.
*66,110	H. F. Wheeler	June 25, "
66.913	Thrasher and Aiken	July 16, "
70,264	S. S. Rembert	Oct. 29, "
71,349	E. Whitney	Nov. 26, "
76,734	C H. Alsop	Apr. 7, 1868.
82,908	D. Werner	Oct. 6, "
*87,038	W. Gardner	Feb. 16, 1869.
88,605	W. Briggs	Apr. 6, "
92,799	L. Delassize	July 20, "
*112,795	H. K. Forbis	Mar. 21, 1871.

2. *Tilting. (a.) Down at Muzzle and up at Breech.*

No.	Name.	Date.
147	T. McCarty	Mar. 11, 1837.
203	H. C. Fay	May 22, "
960	S. Adams	Oct. 3, 1838.
1,810	S. Day	Oct. 18, 1840.
8,126	E. Maynard	May 27, 1851.
11,477	J. C. Day	Aug. 8, 1854.
13,941	J. C. Day	Dec. 18, 1855.
14,057	L. H. Gibbs	Jan. 8, 1856.
16,761	Tilton and Floyd	Mar. 3, 1857.
17,642	J. P. Schenkl	June 23, "
22,752	C. Sharps	Jan. 25, 1859
24,730	Gallagher and Gladding	July 12, "
25,926	Wesson and Harrington	Oct. 25, "
26,364	E. Maynard	Dec. 6, "
27,399	J. M. Wampler	Mar. 6, 1860.
27,723	Letort and Mathews	Apr. 3, "
29,152	M. J. Gallagher	July 17, "
30,228	F. Jones	Oct. 2, "
30,372	C. O. Wood	Jan. 1, 1861.
31,050	C. O. Wood	Jan. 1, "
32,653	H. Schroder	June 25, "
32.895	C. D. Schubarth	July 23, "
36,571	M. Moses	Sept. 30, 1862
36,925	F. Wesson	Nov. 11, "
39,494	J. Percy	Aug 11, 1863.
39,707	C. E. Sneider	Aug. 25, "
42,648	W. H. Elliot	May 10, 1864.
42,649	W. H. Elliot	May 10, "
42,698	E. T. Starr	May 10, "
43,929	G. J. Richardson	Aug. 23, "
44,123	J. Stevens	Sept. 6, "
44,290	W. C. Dodge	Sept. 20, "
44,312	W. D. Hillis	Sept. 20, "
46,054	C. E. Sneider	Jan. 24, 1865.
47,755	C. E. Sneider	May 16, "
48,966	E. Maynard	July 25, "
50,048	T. L Sturtevant	Sept. 19, "
50,432	W. Richards	Oct. 10, "
50,854	T. L. Sturtevant	Nov. 7, "
52,654	A. Henry	Feb. 13, 1866.

2. *Tilting. (a.) Down at Muzzle, etc.* — Continued.

No.	Name.	Date.
52,938	J. F. C. Carle	Feb. 27, 1866.
55,613	J. Burke	June 19, "
59,110	E. Wetmore	Oct. 23, "
59,706	P. Bourdereaux	Nov. 13, "
59,723	W. H Miller	Nov. 13, "
60,592	T L. Sturtevant	Dec. 18, "
62,465	A. I. Burgess	Feb. 26, 1867.
64.941	G. W. Bowlby	May 21, "
65,783	T. W. Webley	June 11, "
70,463	W R. Pape	Nov 5. "
71,149	J. Elson	Nov. 19, "
72.434	D. B. Wesson	Dec. 17. "
78,519	E. H. Escherich	June 2, 1868.
78,847	D. B. Wesson	June 9, "
84 373	W. R. Pape	Nov. 24, "
85,252	C. E. Sneider	Dec. 22. "
87,814	G. T. Abbey	Mar. 16, 1869.
88,470	W. Golcher	Mar. 30, "
88,890	J. McGovern	Apr. 13, "
89,947	G. Schulz	May 11, "
90,214	F. Wohlgemuth	May 18, "
91,616	L. T. Fairbanks	June 22, "
91,624	J. A Hackenback	June 22, "
93,023	G. H. Todd	July 27, "
95,998	W. Golcher	Oct. 19, "
100,455	E. L. Sargent	Mar. 1, 1870.
104,502	E. L. Sargent	June 21, "
104,682	L. V. Young	June 21, "
108,942	M M. Scott	Nov. 1, "
109,255	E. L. Sargent	Nov. 15, "
109 890	C. Green	Dec. 6, "
112,763	W. C. Dodge	Mar 14, 1871.
114,081	Abbey and Foster	Apr. 25, "
114,230	Tiesing and Gerner	Apr. 25, "
114,374	D. B. Wesson	May 2, "
114,653	W. C. Dodge	May 9, "
117,843	A. E. Whitmore	Aug. 8, "
118,350	Dodge and Dodge	Aug. 22, "
119,474	G. R. Peirce	Oct. 3, "
119,834	G. H. Ferriss	Oct 10. "
125,775	A. E. Whitmore	Apr. 16, 1872.
130,984	F. S. Dangerfield	Sept. 3, "
131,484	H. Walker	Sept 17. "
135,928	E. Maynard	Feb. 18, 1873.
138,887	J. S. Heath	May 13, "
141,198	P. Bourdereaux	July 29, "

2. *(b.) With Muzzle upward.*

No.	Name.	Date.
24,774	P. Altmaier	July 12. 1859.
34,729	H Berg	Mar. 25, 1862
51,440	W H. Elliot	Dec. 12, 1865.

2. *(c.) On Hinged Joint.*

No.	Name.	Date.
15,496	G. Smith	Aug. 5, 1856.
22,094	J. C. Symmes	Nov. 16, 1858.
23,762	W. C. Ellis	Apr. 26, 1859.
27,600	E Sneider	Mar. 20, 1860.
32,929	A. Spellerberg	July 30, 1861.
35,356	H. Kellogg	May 20. 1862.
49,844	J. D. Dougall	Sept. 5, 1865.
54,680	J. Burke	May 15, 1866.
60,698	S. Crispin	Jan. 1, 1867.
93,403	J. D. Blaker	Aug. 10, 1869.

3. *Swinging Laterally on Vertical Pin.*

No.	Name.	Date.
35,941	J. Lee	July 22, 1862.
43,259	S. M. Perry	June 21, 1864.

3. *Swinging Laterally on Vertical Pin.* — Continued.

No.	Name.	Date.
43,260	S. M. Perry	June 21, 1864.
46,[illegible]17	E. Allen	Mar. 7, 1865.
47,395	J. W. Cochran	Apr. 25, "
51,950	F. D Newbury	Jan. 9, 1866.
63,505	C H. Ballard	Apr. 9 1867.
98,579	G. H. Fox	Jan. 4, 1870.
101,637	J. M Marlin	Apr. 5, "
102,429	Perry and Goddard	Apr. 26, "
102,434	E. S. Renwick	Apr. 26, "
105 388	F. A. Tauer	July 12, "
137,927	A. E. and P. J. Jarre	Apr. 15, 1873

4. *Rotating on Parallel Longitudinal Pin.*

No.	Name.	Date.
8 637	R. S. Lawrence	Jan. 6, 1852.
11,157	J. D Greene	June 27, 1854.
13,691	H. B. Weaver	Oct. 16, 1855.
*14,031	J. C. Smith	Jan. 1, 1856.
*27,374	J. D. Moore	Mar. 6, 1860.

4. *Rotating on Parallel Longitudinal Pin.* — Continued.

No.	Name.	Date.
27,778	C. Cox	Apr. 10, 1860.
29,340	R. F. Cook	July 24, "
31,473	D. Moore	Feb. 19, 1861.
*32,316	L. Siebert	May 14, "
35,241	W. Johnston	May 13 1862.
37,025	Armstrong and Taylor	Nov. 25, "
*37,854	R. F. Cook	Mar. 10, 1863.
37,937	Jackson and Goodrem	May 17, "
42,227	A. H. Rowe	Apr. 5, 1864.
43,571	Francis Clark	July 19, "
43,840	W. H. Elliot	Aug. 16, "
44,868	W. Johnston	Nov. 1, "
*45,361	L. Triplett	Dec. 6, "
49,057	M. L. M. Descoutures	July 25, 1865.
50,760	H. F. Wheeler	Oct. 31, "
55,752	H. F. Wheeler	June 19, 1866.
58,064	W. J. Christy	Sept 18, "
73 494	Boyd and Tyler	Jan. 21, 1868.
88,540	Boyd and Tyler	Apr. 6, 1869.
103,694	F. Wesson	May 31, 1870.
106,083	Simpson, Gray, and Romana	Aug. 2, "
112,803	Gray and Romans	Mar. 21, 1871.

Class B. — Breech-Block moving with Relation to Barrel.

1. *Sliding Longitudinally Backward.* (*a.*) *Operated by a Lever.*

No.	Name.	Date.
747	W. Jenks	May 25, 1838.
7 443	W. W. Marston	June 18, 1850.
*8,317	H. Smith	Aug. 26, 1851.
*10,535	Smith and Wesson	Feb. 14, 1854.
15,995	G. W. Morse	Oct. 28, 1856.
16,797	W. C. Hicks	Mar. 10, 1857.
20,825	G. H. Soule	July 6, 1858.
20,954	J. H Merrill	July 20, "
*30,446	B. F. Henry	Oct. 16, 1860.
30,714	J. Boynton	Nov. 27, "
32,032	J. H. Merrill	Apr. 9, 1861.
32,033	J. H. Merrill	Apr. 9, "
32,451	J. H Merrill	May 28, "
33,536	J. H. Merrill	Oct. 22, "
33,847	D. Moore	Dec. 3, "
34,859	C. B. Holden	Apr. 1, 1862.
35.284	W. H. Elliot.	May 13, "
35,989	C. C. Brand	July 29, "
*36 174	J. Q. A Scott	Aug. 12, "
36,721	J. V. Meigs	Oct. 21, "
36,779	S. Howard	Oct. 28, "
37,376	Le Roy S. White	Jan. 6, 1863.
38 280	C. C. Brand	Apr. 28, "
38,645	E. H. Ashcroft	May 26, "
38,943	C C Rrand	June 23, "
40,884	J. H Merrill	Dec. 8, "
41.814	W. C. Hicks	Mar. 1, 1864
42,941	H. Gross	May 31, "
45.202	Bergen and Williamson	Nov. 22, "
*45,466	J. F. Appleby	Dec. 20, "
46,977	D. Williamson	Mar. 21, 1865.
48,337	Joshua Gray	June 20, "
49,463	W. F. Wilson and H. Flather	Aug. 15, "
50,125	C. Howard	Sept. 26, "
50.358	C Howard	Oct. 10. "
*52,933	J. D. Smith	Feb 27, 1866.
*52,934	J. D Smith	Feb. 27, "
*55,012	N. King	May 22, "
*56,939	H. W. Hayden	Aug. 7, "
*57,636	N. King	Aug. 28, "
*57,808	O. F. Winchester	Sept. 4, "
*58,937	G. W. Briggs	Oct. 16, "
*59,126	V. Fogerty	Oct. 23, "
*63,564	P Sheckler	Apr. 2, 1867.
65,812	W W Hubbell	June 18, "
*66,651	E. L. Sturtevant	July 16, "
68,785	M. Pidault and G. Elieze (dit Lagieze)	Sept 10, "
*82,819	V Fogerty	Oct. 6, 1868.
*84,598	L. Wheelock	Dec. 1, "
85 616	P. Schuler	Jan. 5, 1869.
*86,723	S. G. Bayea	Feb. 9, "

1. *Sliding Longitudinally Backward.* (*a.*) *Operated by a Lever.* — Continued.

No.	Name.	Date.
86,739	T. M. Deprez	Feb. 9, 1869.
86,971	T. B. Conklin	Feb. 16, "
87,997	D. Williamson	Mar 16, "
*111,500	L. Wheelock	June 31, 1871.
*112,563	H. J. Drew	Mar. 14, "
*112,564	H. J. Drew	Mar. 14, "
*116,642	G. R. Stetson	July 4, "
*125,988	O M Robinson	Apr. 23, 1872.
127,873	William W. Hannah	June 11, "

1. (*b.*) *Withdrawn by Hand by a Thumb or Spring Catch, or by a Handle, and fastened by a Bayonet-Catch.*

No.	Name.	Date.
6,871	C. Hartuog	Nov. 13, 1849.
*6,973	L Jennings	Dec. 25, "
7,334	J. Murfflein	Apr. 30, 1851.
11,198	A. N. Newton	June 27, 1854.
11,835	C. F. and A H. Palmire	Oct. 24, "
11,938	F. Maton	Nov. 14, "
15,522	A. N. Newton	Aug. 12, 1856.
16,072	C. Sharps	Nov. 11, "
18,634	J. Durell Greene	Nov. 17, 1857.
25,470	J. Rider	Sept. 13, 1859.
26,475	B. Burtoo	Dec. 20, "
32,450	J. H Merrill	May 28, 1861.
34,084	F. G. Woodard	Jan. 7, 1862.
34 422	J. D. Greene	Feb. 18, "
34,706	T. Twickeler	Mar. 18, "
34,911	J. L Swan	Apr. 8, "
35,107	J. P. Marshall	Apr. 29, "
36,681	W. Terry	Oct. 14, "
36,854	J. C. Nye	Nov. 4, "
37,354	J. C. Nye	Jan. 6, 1863.
37,723	J. K. Millner	Feb. 17, "
38,903	O. D. Lull	June 16, "
39,136	W. H. Elliot	July 7, "
40,572	W. Morgenstern and E. Morwitz	Nov. 10, "
41,017	W. Palmer	Dec. 22, "
44,099	W. R. Landfear	Sept. 6, 1864.
44,127	Townsend and Clement	Sept. 6, "
44,545	D. F. Mellen	Oct. 4, "
45,262	W. Morgenstern	Nov. 29, "
48,133	W. Morgenstern	June 6, 1865.
50.334	N. S. Clement	Oct. 10, "
60,832	A. A. Chassepot	Jan. 1, 1867.
63,217	J. W. Cochran	Mar. 26, "
63,303	Thomas Restell	Mar. 26, "
65,509	E. K. Root	June 4, "
73,351	H. Lord	Jan 14, 1868.
74,387	H. Lord	Feb. 11, "

1. (*b.*) *Withdrawn by Hand, etc.* — Continued.

No.	Name.	Date.
75,627	J. W. Cochran	Mar. 17, 1868.
78,603	S. Morris, W. and P. Mauser	June 2, "
80,043	Thomas Wilson	July 14, "
81,059	B. Burton	Aug. 11, "
81,290	C. B. Richards	Aug. 18, "
*84,459	A. Wylie	Nov. 24, "
85,162	H. Berdan	Dec. 22, "
*85,494	F. Vetterlin	Dec. 29, "
85,645	J. W. Cochran	Jan. 5, 1869.
*85,837	C. W. Baldwin	Jan. 19, "
85,909	Carter and Edwards	Jan. 19, "
86,091	L. A. Merriam	Jan. 19, "
*86,520	V. Fogerty	Feb. 2, "
86,536	E. Maynard	Feb. 2, "
86,630	L. Remington	Feb. 9, "
87,058	L. A. Merriam	Feb. 16, "
88,131	J. D. Greene	Mar. 23, "
88,730	J. D. S. Newell	Apr. 6, "
89,902	S. F. Van Choate	May 11, "
90,381	J. D. S. Newell	May 25, "
*92,013	B. Burton	June 29, "
92,048	M. J. Hinden	June 29, "
*92,129	W. G. Ward	June 29, "
93,822	B. B. Hotchkiss	Aug. 17, "
94,047	S. F. Van Choate	Aug. 24, "
94,458	W. G. Ward	Aug. 31, "
94,577	F. V. Diaz	Sept. 7, "
97,167	A. A. Chassepot	Nov. 23, "
97,734	W. G. Ward	Dec. 7, "
*97,821	W. S. Smoot	Dec. 14, "
99,504	W. G. Ward	Feb. 1, 1870.
99,898	B. B. Hotchkiss	Feb. 15, "
101,823	J. J. Cloes	Apr. 12, "
103,488	A. Muller	May 24, "
*103,504	O. M. Robinson	May 24, "
104,100	K. V. Barnekoo	June 14, "
108,836	P. Schuler	Nov. 1, "
108,859	H. Berdan	Nov. 1, "
109,218	B. F. Joslyn	Nov. 15, "
109,277	F. Vetterlin	Nov. 15, "
109,731	J Hanson	Nov. 29, "
110,353	S Gerogross	Dec. 20, "
110,505	J. Smiles	Dec. 27, "
111,994	W G. Ward	Feb. 21, 1871.
112,523	J. M Mason	Mar. 7, "
115,911	S. F. Van Choate	June 13, "
117,398	Valentine Fogerty	July 25, "
119,939	George Merrill	Oct. 17, "
119,940	George Merrill	Oct. 17, "
124,056	R Goshen	Feb. 27, 1872.
125,829	I M. Milbank	Apr. 16, "
129,312	H. Brugmann	July 16, "
132,505	S. F. Van Choate	Oct. 22, "
134,200	F. Gueury	Dec. 24, "
135,850	I M. Milbank	Mar. 18, 1873.
135,903	H Hoppeneau	Mar. 18, "

2. *Swinging or Tilting.* (*a.*) *Hinged to Top of Barrel, and turning Upward and Forward.*

No.	Name.	Date.
610	H. and C. Daniels	Feb. 15, 1838.
1,611	J. R Thomas	May 19, 1840.
13,507	B. F. Joslyn	Aug. 28, 1855.
14,919	N S Clement	May 27, 1856.
15,307	W. M. Storm	July 8, "
15,515	F. W. Hoffman	Aug 12, "
25,631	J. P. Marshall	Oct. 4, 1859.
33,655	S. W. Marsh	Nov 5, 1861.
*34,776	L. C. Rodier	Mar 25, 1862.
35,531	B. S. Roberts	Sept. 23, "
39,243	W. Richards	July 14, 1863.
40,151	J. H. Wickman	Sept 29, "
45,126	E. S. Wright	Nov. 5, 1864.
47,133	C. Chabot	Apr. 4, 1865.
47,902	W. H. and G W. Miller	May 23, "
49,718	C Chabot	Sept. 5, "
49,959	E S. Allin	Sept. 19, "
51,391	E. S Piper	Dec. 5, "
52,734	I. M. Milbank	Feb. 20, 1866.
52,887	B S. Roberts	Feb. 27, "
52,925	H. Berdan	Feb. 27, "
54,600	H. Reynolds	May 8, "
55,520	I. M. Milbank	June 12, "
57,259	J. H. Selwyn	Aug. 14, "
60,634	A Ball	Jan. 1, 1867.
61,082	I. M. Milbank	Jan. 8, "

2. *Swinging or Tilting, etc.* — Continued.

No.	Name.	Date.
61,865	J. W. Preston	Feb. 5, 1867.
64,701	Poultney and Crispin	May 14, "
65,585	I. M. Milbank	June 11, "
68,099	W. H and G. W. Miller	Aug. 27, "
72,526	W. Morgenstern	Dec. 24, "
74,119	F Muller	Feb. 4 1868.
79,291	W. Morgenstern	June 23, "
86,434	W. Morgenstern	Feb 2, 1869.
87,190	W. Morgenstern	Feb. 23, "
88,435	H. Berdan	Mar 30, "
88,530	A. L. Varney	Mar 30, "
88,531	A. L. Varney	Mar. 30, "
89,889	W. Richards	May 11, "
90,792	W. S. Smoot	June 1, "
93,330	W. Morgenstern	Aug. 3, "
101,418	H. Berdan	Apr. 5, 1870.
105,058	A. B. Ely and E. C. Clay	July 5, "

2. (*b.*) *Hinged to Side of Barrel and Swinging Laterally Forward.*

No.	Name.	Date.
50,670	J von der Papperburg	Oct. 24, 1865.
55,719	A. Sayer	June 19, 1866.
61,715	I. M. Milbank	Feb. 5, 1867.
64,999	J and G. H. Needham	May 21, "
81,283	J. Merlett	Aug 18, 1868.
84,566	I. M. Milbank	Dec. 1, "
109,419	A. B Kay	Nov. 22, 1870.

2. (*c.*) *Hinged beneath Barrel and Swinging Forward and Downward through Mortise.*

No.	Name.	Date.
12,001	A. D. Perry	Nov. 28, 1854.
12,638	R. White	Apr. 3, 1855.
14,491	A. F. Burnside	Mar. 25, 1856.
15,521	F. D. Newbury	Aug. 12, "
20,073	T. Lee	Apr. 27, 1858.
21,523	E. T. Starr	Sept. 14, "
25,470	J. Rider	Sept 13, 1859.
26,362	S. W. Marsh	Dec 9, "
*27,393	C M. Spencer	Mar. 6, 1860.
27,509	N. L. Babcock	Mar. 20, "
27,874	G. P. Foster	Apr. 10, "
33,317	F. Curtis	Sept 17, 1861.
33,745	T Lee	Nov. 19, "
35,217	C. C. Coleman	May 13, 1862.
35,354	J. M. Seymour	May 20, "
35,488	J. C. Cooke	June 3, "
*36,062	C. M. Spencer	July 29, "
36,466	F. W. Howe	Sept. 16, "
37,501	L. Geiger	Jan. 27, 1863.
38,042	I. Hartshorn	Mar. 31, "
39,120	J. W. Cochran	July 7, "
39,646	H. Gross	Aug. 25, "
40,887	J. Rider	Dec. 8, "
40,992	J. W. Cochran	Dec. 22, "
41,281	F. Curtis	Jan. 19, 1864.
41,489	F. Curtis	Feb. 9, "
42,471	G. Hancock	Apr. 26, "
42,702	F. Trulender	May 10, "
43,957	W H. Smith	Aug 23, "
*45,043	G. W. Hughes	Nov. 15, "
45,123	J. Rider	Nov 15, "
45,152	A. Grillet	Nov. 22, "
*45,356	E. Stabler	Dec. 6, "
45,797	J. Rider	Jan. 3, 1865.
*45,952	C. M. Spencer	Jan. 17, "
46,671	F W. Howe	Mar 7, "
*46,828	E. Stabler	Mar. 14, "
46,866	I. Sutvan	Mar. 14, "
47,350	A. M. White	Apr. 18, "
47,372	W. H Elliot	Apr. 18, "
47,809	W H. Elliot	May 23, "
48,227	H. H. Wolcott	June 13, "
48,288	B. F. Joslyn	June 20, "
*49,409	Hughes and Busey	Aug. 15, "
49,994	Foster and Foster	Sept. 19, "
50,507	J. Stillman	Oct. 17, "
51,739	W. H. and G. W. Miller	Dec. 26, "
51,991	H. Berdan	Jan. 9, 1866.
*52,547	W. C. Dodge	Feb. 13, "
53,187	Robertson and Simpson	Mar. 13, "
53,543	J. Rider	Mar. 27, "
*54,068	J. Gray	Apr. 17, "

2. (*c.*) *Hinged beneath Barrel, etc.* —Continued.

No.	Name.	Date.
54 100	C. E. Billings.	Apr. 24, 1866.
54,713	Laidley and Emery	May 15, "
56,309	G. P. and G. F. Foster	July 17, "
56,390	J Bradley	Aug 7, "
58,444	R. McChesney	Oct. 2, "
*58,737	C. M. Spencer	Oct. 9, "
*58,738	C. M. Spencer	Oct. 9, "
59,500	C C. Coleman	Nov 6, "
60,103	H. H. Wolcott	Nov. 27, "
*60,910	T. W. Lane	Jan. 1, 1867.
60,998	H M. and M. J. Chamberlain	Jan. 8, "
61,722	Silas Crispin	Feb. 5, "
62,873	A. S. Munger	Mar 12, "
64,786	W. H. and G. W. Miller	May 14, "
65,103	R. McChesney	May 28, "
*67,242	J. A. Whitney	July 30, "
68,250	W. S. Smoot	Aug 27, "
68,292	W. H. Elliot	Aug 27, "
72 803	L. Conroy	Dec. 31, "
74,428	J. Rider	Feb. 11, 1868.
74,760	B. H. Jenks	Feb 25, "
76,595	J. Broughton	Apr 14, "
89,699	A. C. Stevens	May 4, 1869.
91,421	L. Conroy	June 15, "
92,393	J. T Stokes	July 6, "
104,211	G. W. Schofield	June 14, 1870.
104,337	J. M. Whittemore	June 14, "
111,814	M J. Chamberlain	Feb. 14, 1871.
112,505	Smith and Chamberlain	Mar 7, "
112,694	W. C. and P. T. Dodge	Apr. 4, "
112.997	E. Whitney	Mar 21, "
113,408	W. C. Dodge	Apr 4, "
113,470	Tresing and Oerner	Apr. 4, "
114,742	J. Yglesias	May 9, "
115,997	Eli Whitney	June 13, "
116,105	W. S. Smoot	June 20, "
116,353	W. T. Snedden	June 27, "
116,354	W. T Snedden	June 27, "
117,906	James M. Mason	Aug. 8, "
*118,152	J. Rider	Aug. 15, "
*119,020	W. R. Evans	Sept 19, "
119,993	Horace Updegraff	Sept 19, "
120,788	W. S. Smoot	Nov. 7, "
122,165	B. B. Hotchkiss	Jan. 2, 1872.
122,470	James Lee	Jan. 2, "
122,717	A. T. Freeman	Jan. 16, "
124,994	Eli Whitney	Mar 26, "
125,229	John F. Thomas	Apr. 2, "
126,446	John W. Cochran	May 7, "
127,335	John F. Thomas	May 28, "
127,383	W. C. and P. T Dodge	June 11, "
129,393	M. J. Chamberlain	July 16, "
129,433	D Smith	July 16, "
*129,523	A. Burgess	July 16, "
129,637	E. Whitney and F Tresing	July 16, "
130,155	H. Updegraff	Aug. 6, "
131,487	J. M. Whittemore	Sept. 17 "
131,921	J M. Whittemore	Oct. 1, "
132,740	W. Mont Storm	Nov. 5, "
133.043	W S. Smoot	Nov. 12, "
*134,589	A. Burgess	Jan. 17, 1873.
135,405	M. J. Chamberlin	Feb. 4, "
135,671	C. M Spencer	Feb. 11, "
137,625	C. Sharps	Apr. 8, "
138,157	Holt and Marshall	Apr. 22, "
138,207	D. Smith	Apr. 22, "
141,383	J. Rider	July 20, "
141,384	J. Rider	July 20, "
141,603	Smith and Marshall	Aug 5, "
142,395	D. Hug	Sept. 2, "

2. (*d.*) *Swinging on Centers or Trunnions.*

No.	Name.	Date.
*10,084	E. H. Graham	Oct. 4, 1853.
10,891	J. D Greene	Jan. 3, 1854.
*11,944	E H. Graham	May 16, "
12.244	A. D. Perry	Jan. 16, 1855.
12,905	H. Gross	May 22, "
14,819	E. Snider	May 6, 1856.
*15,731	E. H Graham	Sept. 16, "
17,135	G. A. Blittkowski	Apr. 28, 1857.
39,270	O. R. Bacon	July 21, 1863.
39,455	J. S. Adams	Aug. 14, "
44,377	J. S Adams	Sept. 27, 1864.
45,495	H. W. Hayden	Dec. 20, "

2. (*e.*) *Hinged at Rear to swing Upward and Backward.*

No.	Name.	Date.
...	William Thornton and J. H. Hall	May 21, 1811.
865	H. L. Thistle	Aug. 1, 1838.
1,141	N Starr	May 3, 1839.
3,686	Savage and North	July 30. 1844.
5,141	H. S. North	June 5, 1847.
11.536	W. A Sweet	Aug 15, 1854.
*12,567	A. T. Watson	Mar. 20, 1855.
15 072	H. Gross	June 10, 1856.
18,472	Skinner and Tryon	Oct. 20, 1857.
19,068	W. Burghart	Jan. 12, 1858.
20,503	G. W. Morse	June 8, "
*21,149	F. B. Prindle	Aug. 10, "
23,224	Barber and Reinfried	Mar. 15, 1859.
23,378	E. Lindner	Mar. 29, "
24,394	D. Leavitt	June 14, "
25,259	H. Gross	Aug. 30, "
26,076	W. H. Arnold	Nov. 15, "
32,887	W. Palmer	July 23, 1861.
*34,922	C. Dragar	Apr. 8, 1862.
*35,548	N. Smith	June 10, "
36,891	Bostwick and Sargent	Nov. 11, "
37,048	I. M. Milbank	Dec. 2, "
37,407	J. Oliphant	Jan. 13, 1863.
37,764	C. Perley	Feb. 24, "
*39,541	J. N. Smith	Aug. 18, "
43,733	J. Browness	Aug. 2, 1864.
47,088	J. W. Cochran	Apr. 14, 1865.
51,213	F. B. Prindle	Nov. 28, "
52,679	J. W. Cochran	Feb. 20, 1866.
*135,947	Swingle and Huntington	Feb. 18, 1873.

2 (*f.*) *Hinged at Rear and swinging Laterally.*

No.	Name.	Date.
409	C. Parkhurst	Sept. 25, 1837.
34,319	C. M. Spencer	Feb. 4. 1862.
44,991	E. Whitney	Nov. 8, 1864.
48,073	B. F. Joslyn	June 6, 1865.
133,770	A. T. Freeman	Dec. 10, 1872.
139,190	T. Restell	May 20, 1873.

2. (*g.*) *Hinged at Rear and swinging Downward and Backward through Mortise.*

No.	Name.	Date.
2,627	C. H. Ballard	Nov. 5, 1851.
12,528	R. White	Mar. 13, 1855.
35,947	H. O. Peabody	July 22, 1862.
36,709	E. Gwyn and A. C. Campbell	Oct. 21, "
*38,702	C. M. Spencer	May 26, 1863.
*38,935	A. Ball	June 23, "
39,479	H. Gross	Aug. 11, "
41,166	J. Merwin and E. P. Bray	Jan. 5, 1864.
41 242	W. X. Stevens	Jan. 12, "
*43,827	A. Ball	Aug. 2, "
60,607	T. Yates	Dec. 18, 1866.
65,607	B. S. Roberts	June 11, 1867.
70,141	L. Wheelock	Oct. 22, "
72,076	H. O. Peabody	Dec. 10, "
76,805	H. O. Peabody	Apr. 14, 1868
83,442	E. F. Gunn	Dec. 29. 1868.
*89,705	L. Z. Terrell	May 4, 1869.
90,024	B. S. Roberts	May 11, "
90,614	F. Von Martini	May 25, "
91,668	W. Richards	June 22, "
92,673	Z R. Von Wessely	July 13, "
95,395	A. L. Varney	Sept. 28, "
*105,093	J. Krafftt	July 5. 1870
110,024	W H. Elliot	Dec. 13, "
112,565	J. Duval	Mar. 14, 1871.
114,540	W. H. Elliot	May 9, "
114.951	James Lee	May 16, "
115,541	F. Von Martini	May 30, "
116.068	James Lee	June 20, "
117.552	J. Manton	Aug. 1, "
*119.115	A. Burgess	Sept. 19, "
119,218	A. Burgess	Sept. 26, "
120,576	W. H. Elliot	Nov. 7, "
120.800	F. Von Martini	Nov. 7, "
121,499	W. H. Elliot	Dec. 5, "
122.772	James Lee	Jan. 16, 1872.
123,159	J. Duval	Jan 30, "
125,127	W. H. Elliot	Apr. 2, "
127,737	A. Burgess	June 11, "
128,208	A. Burgess	June 25, "
132,222	F. Von Martini	Oct. 15, "

2. (*g.*) *Hinged at Rear, etc.*—Continued.

No.	Name.	Date.
133,665	W. Richards	Dec. 3, 1872.
134,014	J. F. Swinburn	Dec. 17, "

3. *Sliding Transversely through Mortise.* (*a.*) *Moving Vertically.*

No.	Name.	Date.
*1,084	Bailey, Ripley, and Smith	Feb. 20, 1839.
*5,143	E. Wesson	June 5, 1847.
5,763	C. Sharp	Sept. 12, 1848.
*5,814	M. M. Cass	Sept. 26, "
*6,136	G. W. Buchel	Feb. 20, 1849.
*6,633	W. Hunt	Aug. 21, "
*11,283	E. Baldwin	July 11, 1854.
12,529	R. White	Mar. 13, 1855.
*12,655	G. H. Soule	Apr. 3, "
*13,474	J. Swyny	Aug. 21, "
14,554	C. Conant	Apr. 1, 1856.
*14,774	F. Newbury	Apr. 29, "
15,240	B. F. Joslyn	July 1, "
15,347	G. H. Soule	July 15, "
*20,041	C. Cox	Apr. 27, 1858.
22,940	F. Curtis	Feb. 15, 1859.
24,414	W. M. Storm	June 14, "
24,437	T. Bailey	June 14, "
26,504	R. S. Lawrence	Dec. 20, "
*26,731	T. P. Gould	Jan. 3, 1860.
*28,646	N. W. Brewer	June 12, "
30,033	E. Allen	Sept 18, "
*30,760	J. S. Reeder	Nov. 27, "
33,607	C. Sharps	Oct. 29, 1861.
33,769	A. Hamilton	Nov 19, "
34,325	G. W. White	Feb. 4, 1862.
*34,504	E. M. Judd	Feb. 25, "
35,086	F. Dewzler	Apr. 29, "
37,369	G. W. White	Jan. 6, 1863
37,541	J. Davis	Jan. 27, "
38,455	W. Aldrich	May 12, "
*38,604	W. H. Rice	May 19, "
41,343	Mix and Horton	Jan. 9, 1864.
*41,375	J. Gray	Jan. 26, "
42,139	C. B. Holden	Mar. 29, "
42,685	C. F. Payne	May 10, "
42,743	L. N. Chapin	May 17, "
*44,995	J. Gray	Nov. 8, "
*45,105	R. Wilson	Nov. 15, "
*45,560	J. Gray	Dec. 20, "
*45,919	W. Fitzgerald	Jan. 17, 1865.
49,583	L. W. Broadwell	Aug 22, "
51,243	W. Tibbals	Nov. 28, "
51,258	J. Davis	Nov. 28, "
54,744	J. Lee	May 15, 1866.
54,934	J. V. Meigs	May 22, "
59,540	J. N. Aronson	Nov. 13, "
62,077	C. Sharps	Feb. 12, 1867.
64,650	J. Elson	May 14, "
66,709	A. J. H. Hilton	July 16, "
67,133	J. Elson	July 23, "
81,100	J. V. Meigs	Aug. 18, 1868.
86,387	Elson and Schaefer	Feb. 21, 1869.
88,645	R. S. Lawrence	Apr. 16, "
*88,853	T. Cullen	Apr. 13, "
89,955	L. B. Tiebel	May 11, "
*101,845	D. Ellis	Apr. 12, 1870.
104,775	S. Rydberk	June 28, "
114,259	H. Buchner	May 2, 1871.
*116,066	J. L. Kirk	June 20, "
119,145	Henry	Sept. 19, "
123,595	G. H. Tibbets	Feb. 13, 1872.
126,748	C. F. Russell	May 14, "
*136,660	G. D. Luce	Mar. 11, 1873.
*138,439	Rodier and Bates	Apr. 29, "
138,837	G. Aston	May 13, "
139,323	A. Marelli	May 27, "
139,422	W. Richards	May 27, "

3. (*b.*) *Moving Laterally.*

No.	Name.	Date.
168	Fisher and Chamberlin	Apr. 17, 1837.
14,667	P. Lancaster	Apr. 15, 1856.
*19,387	C. C. Terrill	Feb. 16, 1858.
33,560	Vittum and Stevens	Oct. 22, 1861.
35,665	P. J. Jarre	June 24, 1862.
51,225	E. Schopp	Nov. 28, 1865.

4. *Swinging or rotating Laterally.* (*a.*) *On a Longitudinal Pin or Hinge.*

No.	Name.	Date.
193	W. W. Hubbell	Mar 11, 1837.
*364	S. Day	Aug. 31, "
3,649	W. W. Hubbell	July 1, 1844
6,139	D. Minesinger	Feb. 27, 1849.
*9,701	C. N. Tyler	May 3, 1853.
*14,017	B. Groom	Jan. 1, 1856.
*14,406	F. Newbury	Mar. 1, "
20,315	C. W. Alexander	May 25, 1858
26,526	I. H Sears	Dec 20, 1859.
30,537	E. Maynard	Oct. 30, 1860.
33,435	B. F Joslyn	Oct. 8, 1861.
33,907	W. H. Smith	Dec. 10, "
*34,126	Brady and Noble	Jan. 14, 1862.
34,449	B. F. Skinner and A. Plummer, Jr.	Feb. 18, "
34,854	S. W. Wood	Apr. 1, "
35,688	B. F. Joslyn	June 24, "
*35,996	J. B. Doolittle	July 29, "
*36,358	J. Nichols	Sept. 2, "
37,208	S. Strong	Dec. 16, "
38,366	L. Albright	May 5, 1863.
38,643	S. Strong	May 19, "
38,644	S. Strong	May 19, "
39,198	J. Davis	July 7, "
39,407	B. F. Joslyn	Aug. 4, "
41,732	J. Warner	Feb. 23, 1864.
42,000	B. F. Joslyn	Mar. 22, "
42,529	J. Davis	Apr. 25, "
42,542	I. Smith	Apr. 26, "
42,573	J. Goulding	May 3, "
44,798	H. Hammond	Oct. 25, "
45,630	J. Warner	Dec. 27, "
45,701	Francis Clark	Jan. 3, 1865.
45,899	Hiram Berdan	Jan. 10, "
46,125	I. M Milbank	Jan. 31, "
46,532	J. Rider	Feb. 21, "
48,423	E. Maynard	June 27, "
49,131	E. Maynard	Aug. 1, "
49,491	E. Allen	Aug. 22, "
53,523	F. Clark	Mar. 27, 1866
56,669	J. A. Conover	July 24, "
*56,846	A. M. Bacon	July 31, "
68,736	E. F. Gunn	Sept. 10, 1867
69,941	J. Snider, Jr	Oct. 15, "
72,849	H. Hammond	Dec. 31, "
73,357	J. E. McBeth	Jan. 14, 1868.
74,712	W. Morgenstern	Feb. 18, "
74,737	J. Werndl	Feb. 18, "
74,883	C Callaghan	Feb. 25, "
80,985	J. E. McBeth	Aug. 11, "
84,922	E. Von Oeinsen	Dec. 15, "
84,929	E. Allen	Dec. 15, "
84,938	J. R. Cooper	Dec. 15, "
85,268	Belden and Crabtree	Dec. 29, "
104,223	W. Soper	June 14, 1870.
*112,127	J. Davis	Feb. 28, 1871.
112,589	H. Hammond	Mar. 14, "
118,171	J. B. Wayne	Aug. 15, "
118,569	J. W. Wilkinson	Aug. 29, "
*122,182	T. Lee	Dec. 26, "
*128,671	C. R. Stickney	July 2, 1872.
129,115	G. H. Earnest	July 16, "
133,711	J. P. Taylor	May 6, 1873.

4. (*b.*) *Having the Form of a Rotating Sleeve.*

*7,496	Percival and Smith	July 9, 1850.
16,070	G. Schaeffe	Nov. 11, 1856.

5. *In Form of a Faucet or Spigot.* (*a.*) *Having Chamber in the Faucet.*

*3,945	A. D. Perry	Dec 11, 1845.
*10,520	F. Cook	Feb 14, 1854.
*19,553	A. C. Faivre	Mar. 9, 1858.
20,776	Brooks and Walker	July 6, "
*23,226	P. Boynton	Mar. 15, 1859.
*26,646	P. Boynton	Jan. 3, 1860.
38,772	H. Underwood	June 2, 1863.
39,132	C. W. Howard	July 14, "
45,801	C. G. Saez	Jan. 3, 1865.

5. (*b.*) *Having Chamber in the Barrel in Front of Faucet.*			5. (*b.*) *Having Chamber in the Barrel, etc.* — Continued.		
No.	Name.	Date.	No.	Name.	Date.
11,685	H. W. Adams	Sept 19, 1854.	14,077	J. H. Merrill	Jan. 8, 1856.
12,581	F. Klein	Apr. 10, 1855.	15,930	T A. Washington	Oct. 28, "
13,154	E. Allen	July 3, "	113,194	R. Henninger	Mar. 28, 1871.

Class C. — Revolvers.

[The dagger (†) signifies that the cylinder has a cartridge-shell extractor.]

1. *Chambered Cylinder revolving on Parallel Axis.* (*a.*) *Behind a Barrel; Cylinder charged at Front.*		
No.	Name.	Date.
...	D. G. Colburn	June 29, 1833.
...	Samuel Colt	Feb. 25, 1835.
132	D. Leavitt	Apr. 29, 1837.
*354	S. Day	Aug. 3, "
215	O. W. Whittier	May 30, "
409	C. Parkhurst	Sept. 25, "
693	Theo. F. Strong	Apr. 21, 1838.
707	Nichols and Childs	Apr. 24, "
713	M. Nutting	Apr. 25, "
832	E. Jaquith	July 12, "
1,106	E. B Butterfield	Mar. 15, 1839.
1,134	D. Edwards	Apr. 27, "
1,304	Samuel Colt	Aug. 29, "
5,315	L. H. Gibbs	Oct. 2, 1847.
6,669	E. Wesson	Aug. 28, 1849.
7,613	Samuel Colt	Sept. 4, 1850.
7,629	Samuel Colt	Sept. 4, "
7,802	J. Stevens	Nov. 26, "
7,894	J. Warner	Jan. 10, 1851.
8,229	J. Warner	July 15, "
8,412	J. Stevens	Oct. 7, "
8,932	North and Skinner	June 1, 1852.
9,394	Robert Adams	May 3 1853.
9,929	J. Stevens	Aug. 9, "
10,259	M. L. Rood	Nov. 22, "
10,312	J. Ells	Apr. 25, 1854.
10,321	Charles Buso	Apr. 25, "
10,930	J. Peck	May 16, "
11,419	J. Ells	Aug. 1, "
11,447	E. Whitney	Aug 1, "
11,470	I. W Brown	Aug. 8, "
11,593	W. H. Morrison	Sept. 19, "
11,715	F. Beals	Sept. 26, "
12,139	J. Stevens	Jan. 2, 1855.
12 328	A. O. H. P. Seborn	Jan. 30, "
12,470	Hollingsworth and Mershon	Feb. 27, "
12,471	Hollingsworth and Mershon	Feb 27, "
12,555	F. Newbury	Mar 20, "
12,649	R. White	Apr. 3, "
12,905	H. Gross	May 22, "
13,039	F. Newbury	June 12, "
13.582	F. Newbury	Sept. 18, "
13,660	W. M. Storm	Oct. 9, "
13,999	E. K. Root	Dec. 25, "
14,406	F. Newbury	Mar. 11, 1856.
14,420	W. M. Storm	Mar 11, "
14,438	Blittkowski and Hoffman	Apr. 22, "
14,710	Blittkowski and Hoffman	Apr. 22, "
14,905	Samuel Colt	May 20, "
15,110	Alexander Hall	June 10, "
15,144	H. S. North	June 17, "
15,167	F. Beals	June 24, "
15,202	James Warner	June 24, "
15 338	C. S. Pettengill	July 22, "
15,925	Alexander Le Mat	Oct. 21, "
16,367	E. Allen	Jan. 13, 1857.
16,411	A. Tonks	Jan. 13, "
16,575	Brettell and Frisbie	Feb. 10, "
16,683	Samuel Colt	Feb. 24, "
16,716	Samuel Colt	Mar. 3, "
17,032	J. Ellis	Apr. 14, "
17,044	James Kerr	Apr. 14, "
17,143	J. Ellis	Apr. 28, "
17,359	F. Beals	May 26, "
*17,383	E. Lindner	May 26, "
17,698	Jacob Shaw, Jr.	June 30, "
17,904	J. Warner	July 28, "
18,483	George R. Crooker	Oct. 20, "
18,678	Samuel Colt	Nov. 24, "

1 *Chambered Cylinder revolving on Parallel Axis.* (*a.*) *Behind a Barrel; Cylinder charged at Front.* — Continued.		
No.	Name.	Date.
18,836	E. Allen	Dec. 15, 1857.
19,327	F. D. Newbury	Feb. 9, 1858.
19,739	F. D Newbury	Mar. 23, "
19,858	H. S. North	Apr. 6, "
20,144	Samuel Colt	May 4, "
20,130	B. F. Joslyn	May 4, "
20,496	M. Kinsey	June 8, "
20,765	F D. Newbury	June 29, "
21,054	Raymond and Robitaille	July 27, "
21,215	J. Rider	Aug 17, "
21,478	F. Beals	Sept. 14, "
21,623	William Palmer	Sept. 28, "
21,730	T R. Austin	Oct. 12, "
22,412	J. W. Cochran	Dec. 28, "
22,511	C. S. Pettengill	Jan. 4, 1859.
22,656	North and Savage	Jan. 18, "
22,905	J. Walch	Feb. 8, "
23,087	W. C. Haynes	Mar. 1, "
23,711	J. Rupertus	Apr. 19, "
23,861	J. Rider	May 3, "
24 274	T. Bailey	June 7, "
24,312	Alexander Le Mat	June 7, "
24,942	Lewis and Pflegar	Aug. 2, "
26,641	Gruler and Rebety	Dec. 27, "
27,518	W. H Bell	Mar. 20, 1860.
27,858	F. D. Newbury	Apr. 10, "
28,331	Savage and North	May 15, "
29,213	C R. Alsop	July 17, "
29,538	C. R Alsop	Aug. 7, "
29,864	J. M. Cooper	Sept. 4, "
30,260	Aug. Spellier	Oct 2, "
30,494	F. D. Newbury	Oct. 23, "
30,602	John Adams	Nov. 6, "
30,843	E T. Starr	Dec. 4, "
32,333	C. R. Alsop	May 14, 1861.
32,685	J. A. De Brame	July 2, "
33,770	C. H. Alsop	Nov. 26, "
33,932	W. H. Elliot	Dec. 17, "
34,032	Thomas Shaw	Dec. 24, "
34,093	W. J. Pitt	Jan. 7, 1862.
34.226	C. R. Alsop	Jan. 21, "
34,803	C. R. Alsop	Mar 25, "
35.052	J. A. Whalen	Apr. 22, "
35,404	A. C. Vaughan	May 27, "
35,999	G. W. B. Gedney	July 29, "
36,861	H. S. Rogers	Nov. 4, "
37.004	T. J. Mayall	Nov. 25, "
37.329	F. Beals	Jan. 6, 1863.
37,921	S. Remington	Mar. 17, "
37,961	A. Hall	Mar. 24, "
38.336	James Reid	Apr. 28, "
38,934	L. W. Pond	June 16, "
39,409	James Kerr	Aug 4, "
39,771	C. W. Harris	Sept. 1, "
39.825	Mershon and Hollinsworth	Sept. 8, "
39.869	J. H Vickers	Sept. 8, "
40.021	J. M. Cooper	Sept 22, "
40,553	J. W. Cochran	Nov. 10, "
41,184	D. Williamson	Jan. 5, 1864.
41,803	S. W. Wood	Mar. 1, "
41,848	B. Kittredge	Mar. 8, "
42.435	Thomas Gibson	Apr. 19, "
43,709	Robitail and Dahis	Aug. 2, "
44,303	S. Guilbert	Sept. 20, "
44,363	S. W. Wood	Sept 20, "
45,290	R. White	Nov. 29, "
45,532	E. T. Starr	Dec. 20, "
46,131	F. D. Newbury	Jan 31, 1865.
46,612	C. E. Sneider	Feb. 28, "

1. *Chambered Cylinder revolving on Parallel Axis. (a.) Behind a Barrel; Cylinder charged at Front.*—Continued.

No.	Name.	Date.
47,707	W. H. Elliot	May 9, 1865.
47,712	G H. Gardner	May 16, "
48,287	B. F. Joslyn	June 20, "
51,528	E. T. Starr	Dec. 19, "
51,690	G C. Bunsen	Dec. 26, "
52,105	S. W. Wood	Jan. 16, 1866.
53,935	G. S. Crowell	Apr. 17, "
55,743	William Tibbals	June 19, "
56,465	William Tibbals	July 17, "
*65,742	E. J. Frost	June 11, 1867.
66,512	R. White	July 9, "
72,844	J. Gordon	Dec. 31, "
82,258	F. A. Thuer	Sept. 15, 1868.
99,843	B. R. Hill	Feb. 15, 1870.
109,914	Linberg and Phillips	Dec. 6, "
112,471	E. S. Leaycroft	Mar. 7, 1871.
112,472	E. S. Leaycroft	Mar. 7, "
115,258	E. Whitney	May 23, "
129,334	J. Gordon	July 16, 1872.
134,442	O. Schneelock	Dec. 31, "
142,376	B K. Dorwart	Sept. 2, 1873.

1. (*b*) *Behind a Barrel; Cylinder charged at Rear.*

No.	Name.	Date.
12,648	R. White	Apr. 3, 1855.
15,032	F. B. E. Beaumont	June 3, 1856.
19,351	R White	Apr. 13, 1858.
20,907	F H Harrington	June 15, "
21,490	E. Allen	Sept. 7, "
22,005	E. Allen	Nov. 9, "
22,318	E. Claude	Dec. 21, "
24,635	Smith and Wesson	July 5, 1859.
24,726	Ells and White	July 12, "
26,919	Morris and Brown	Jan. 24, 1860.
27,525	J. M. Cooper	Mar. 20, "
28,437	A. J. Gibson	May 22, "
28,951	E. Allen	July 3, "
29,126	A J. Gibson	July 10, "
30,079	D. Moore	Sept. 18, "
30,245	E. A. Prescott	Oct. 2, "
30,309	A. J. Gibson	Oct. 9, "
30,755	C. Sharps	Nov. 27, "
30,990	Smith and Wesson	Dec. 18, "
33,328	Ethan Allen	Sept. 24, 1861.
33,509	E. Allen	Oct. 22, "
33,835	H. Gross	Dec 3, "
34,015	A. Smith	Dec. 24, "
34,067	D. Moore	Jan. 7, 1862.
34,703	C. E. Sneider	Mar. 18, "
34,922	C. Draeger	Apr. 8, "
35,067	E. Allen	Apr. 29, "
35,419	C. W. Hopkins	May 27, "
35,523	L. W Pond	June 17, "
35,657	J. H Vickers	June 17, "
36,505	C. C. Brand	Sept. 23, "
36,934	S. W. Wood	Nov. 18, "
37,004	T. J. Mayall	Nov. 25, "
37,069	J. Rupertus	Dec. 2, "
37,075	J Jenkinson	Dec. 2, "
37,091	A. T Freeman	Dec. 9, "
37,551	F. P. Slocum	Jan. 27, 1863.
37,593	J. C. Howe	Feb. 17, "
38,204	F. P. Slocum	Apr. 14, "
38,279	C C. Brand	Apr. 28, "
38,341	D. Moore	Apr. 28, "
38,921	Smith and Wesson	June 16, "
39,318	Ellis and White	July 21, "
39,405	B. F. Joslyn	Aug. 4, "
†39,405	B F. Joslyn	Aug. 4, "
39,510	S. W. Wood	Aug. 18, "
39,512	M. F. Geraghty	Aug 25, "
39,545	H. Gross	Aug 25, "
39,850	H D. Ward	Sept. 8, "
40,537	E. H. Graham	Nov. 24, "
41,117	Briggs and Hopkins	Jan. 5, 1864.
41,857	W. Palmer	Mar 8, "
42,379	B. F. Joslyn	Apr. 19, "
†42,588	H Reynolds	May 10, "
42,823	D Williamson	May 17, "
43,529	R. D. O. Smith	July 12, "
44,123	W. Tileston	Sept. 6, "
44,953	F. W Hood	Nov. 8, "
45,176	H. Reynolds	Nov. 22, "
†45,912	W. C. Dodge	Jan. 17, 1865.
†45,983	W. C. Dodge	Jan. 24, "

1. (*b.*) *Behind a Barrel; Cylinder charged at Rear.*—Continued.

No.	Name.	Date.
46,023	R. H. Plass	Jan. 24, 1865.
†46,225	W. H. Elliot	Feb. 7, "
46,243	B. F. Joslyn	Feb. 7, "
46,562	P. Haughain	Feb. 28, "
47,252	A. Guerriere	Apr. 11, "
47,775	J. H. Vickers	May 16, "
48,287	B. F. Joslyn	June 20, "
†48,775	L. C. Rodier	July 11, "
50,224	S. Crispin	Oct. 3, "
51,092	Smith and Wesson	Nov. 21, "
†51,117	W. Mason	Nov. 21, "
51,269	J. Rider	Nov. 28, "
51,836	B. F. Joslyn	Jan. 2, 1866.
†51,985	E. Whitney	Jan. 9, "
†52,165	H. Hammond	Jan. 23, "
52,248	H. S. Josselyn	Jan. 23, "
52,582	B. T. Loomis	Feb. 13, "
53,539	W. Mason	Mar. 27, "
†53,548	P. Polain	Mar. 27, "
†53,881	S. H. Roper	Apr. 10, "
†54,065	J. B. Doolittle	Apr. 17, "
57,864	A. Christ	Sept. 11, "
59,629	A. L. Munson	Nov. 13, "
63,450	R W. Drew	Apr. 2, 1867.
65,510	E. K. Root	June 4, "
75,016	G. Holman	Mar. 3, 1868.
85,350	J. Adams	Dec. 29, "
†93,572	R. White	Aug. 10, 1869.
†93,653	R. White	Aug. 10, "
†94,003	C. A. King	Aug 24, "
97,780	F. A. Le Mat	Dec. 14, "
†99,505	R. White	Feb. 1, 1870.
†99,690	J. M. Marlin	Feb. 8, "
99,693	J. C. Miller	Feb. 8, "
100,227	R. White	Feb. 22, "
102,782	Felix and De Dartien	May 10, "
103,013	G. W. H. Calver	May 17, "
104,836	W. I. Page	June 21, "
†109,417	B. F. Joslyn	Nov. 22, "
†111,534	G. H. Harrington	Feb. 7, 1871.
113,053	S. S. Hopkins	Mar. 28, "
115,483	B. F. Joslyn	May 30, "
115,916	F. Wesson	June 13, "
116,078	Moss and Johnson	June 20, "
116,422	Forehand and Wadsworth	June 27, "
†116,559	F. G. Cochran	July 4, "
†116,593	F. W. Hood	July 4, "
†117,461	C. B. Richards	July 25, "
†118,752	C. Sharps	Sept. 5, "
119,048	C. B. Richards	Sept. 19, "
121,199	J. Rupertus	Nov. 21, "
122,182	T. Lee	Dec. 26, "
†128,644	W Mason	July 2, 1872.
†128,991	Wesson and King	July 16, "
132,357	J. Davis	Oct. 22, "
133,732	C. S. Wells	Dec. 10, "
135,377	O. A. Smith	Jan. 28, 1873.
135,378	O. A. Smith	Jan. 28, "
†136,131	W. Clews	Feb. 25, "
†136,348	D. B. Wesson	Feb. 25, "
†136,871	Smith, Smith, and Sweeney	Mar. 18, "
†137,043	D. Williamson	Mar. 18, "
137,958	O. A. Smith	Apr. 15, "
†138,047	G. W. Schofield	Apr. 22, "
139,461	C. Foehl	June 3, "
140,028	C. F. Galand	June 17, "
140,516	J. M Marlin	July 1, "
142,175	W. H. Philip	Aug. 26, "

1. (*c.*) *Cylinder without other Barrel* ("*Pepper-Box*").

....	B. and B. M. Darling	Apr. 13, 1836.
3,998	E. Allen	Apr. 16, 1845.
6,453	J. Post	May 15, 1849.
6,723	G. Leonard, Jr.	Sept. 18, "
6,925	Pecare and Smith	Dec. 4, "
7,300	D. H Chamberlain	Apr. 23, 1850.
7,493	G Leonard, Jr.	July 9, "
7,887	S. W. Marston	Jan. 7, 1851.
9,922	George Leonard	Aug. 9, 1853.
13,581	W. W. Marston	Sept. 18, 1855.
14,118	E. T. Starr	Jan. 15, 1856.
15,797	J. Adams	Sept. 30, "
21,188	W. H Elliot	Aug. 17, 1858.
28,460	W. H. Elliot	May 29, 1860.

1. (*c.*) *Cylinder without other Barrel, etc.* — Continued.

No.	Name.	Date.
28,461	W. H. Elliot	May 29, 1860.
33,382	W. H. Elliot	Oct. 1, 1861.
39,032	J. C. Campbell	June 30, 1863.
42,648	W. H. Elliot	May 10, 1864.
43,306	J. Rupertus	July 19, "
51,752	J. Reid	Dec. 26, 1865.
57,448	J. H. Vickers	Aug. 21, 1866
57,622	Converse and Hopkins	Aug. 28, "
84,976	F. Wesson	Dec. 15, 1868.

2. *Chambered Cylinder revolving on Vertical Axis behind a Barrel.*

No.	Name.	Date.
133	J. W. Cochran	Apr. 28 1837.
188	J. W. Cochran	Apr 29, "
603	Haviland and Bennett	Feb. 15, 1838.
677	H. and C. Daniels	Apr. 5, "
7,218	H. Iverson	Mar. 23, 1850.

2. *Chambered Cylinder revolving on Vertical Axis behind a Barrel.* — Continued.

No.	Name.	Date.
12,235	E. H Graham	Jan. 16, 1855.
14,780	S. F Stanton	Apr. 29, 1856.
15,734	E. H. Graham	Sept 16, "
16,477	H. Genhart	Jan. 27, 1857.

3. *Cylinder revolving on Horizontol Axis behind a Barrel.*

No.	Name.	Date.
8,210	P. W. Porter	July 8, 1851.
10,944	E. H. Graham	May 16, 1854.
11,917	W. Wright	Nov. 7, "

4. *Revolving Hammer acting on several Stationary Barrels.*

No.	Name.	Date.
6,960	C. Sharps	Dec 18, 1849.
17,386	W. W. Marston	May 26, 1857.
22,753	C. Sharps	Jan. 25, 1859.
42,698	E. T. Starr	May 10, 1864.

For illustrations of revolvers, see under the head REVOLVER.

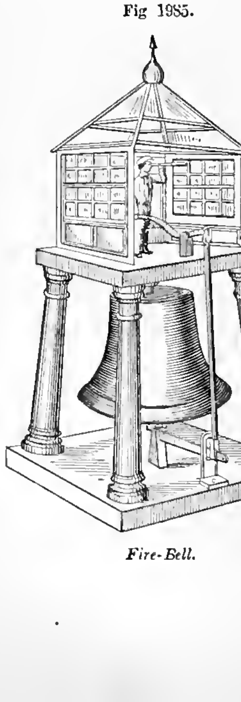
Fire-ar'row. An arrow carrying a combustible for incendiary purposes.

Fire-back. The back-wall of a furnace or fire-place. It is frequently of fire-brick, in order to protect the iron walls of the furnace, but is sometimes of iron ribbed, partly to protect and stiffen it and partly to allow access of air close to it. Sometimes the fire-back is perforated to admit air at that point; or it may be hollow, and form a heater for water for household purposes.

Fire-ball. A projectile of oval shape, formed of a sack of canvas filled with combustible composition. They are thrown into an enemy's works for the purpose of lighting them up, and are loaded with shells to prevent them from being approached. A wrought-iron bottom is attached to the bag to prevent breakage when discharged.

Fire-bal-loon'. 1. A balloon whose ascensional power is derived from a body of heated air rising from a fire beneath the open mouth of the bag. Montgolfier's balloon was of this kind. See BALLOON.

Fig 1985.



Fire-Bell.

2. A balloon sent up at night with fire-works.

Fire-bar. A grate-bar in a furnace resting on a frame, called the *fire-bar frame;* inside the *fire-box.* See GRATE-BAR.

Fire-bas'ket. A portable grate or cresset.

Fire-bell. A fire-alarm bell. One designed to indicate by a definite number of strokes the district or locality in which a conflagration is prevailing.

The illustration shows a striking-apparatus consisting of a series of levers connected with the clapper of the bell, and operated by a person stationed in a lookout-lantern above.

The signal-bells are now usually sounded by electricity. See FIRE-ALARM TELEGRAPH.

Fire-board. A board to close a fireplace in summer.

Fire-box. The fire-chamber of a locomotive-boiler. It is jacketed with a water-chamber to prevent radiation of heat. The fire-box door may also be double and have a circulation of water through the hinges. A *partition* in the box sometimes divides the fire-space into two parts, and, being full of water, increases the fire surface.

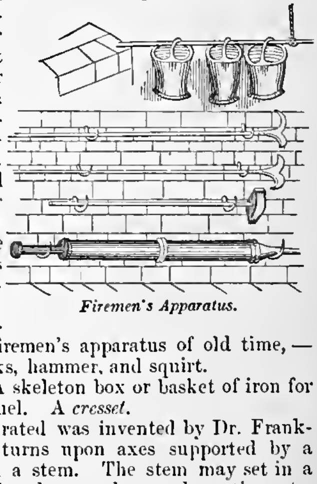
Fire-box stays are rods which prevent the crushing down of the top of the box by the pressure of steam.

Fire-brick. A brick of refractory clay for lining furnaces, ovens, etc. Fire-clay is a nearly pure silicate of alumina.

Fire-bridge. A plate or wall at the back of the furnace to support the ends of the grate-bars and prevent the fuel being carried over. It also serves to give an up turn to the flames against the bottom of the boiler.

Fire-buck'et. One made of canvas, leather, or wood, and kept in readiness for emergencies. On board ship, a fire-bucket has a sennit lanyard of a length regulated to reach the water alongside, from the station whence the fire-bucket is to be thrown overboard to be filled.

Fig. 1986.



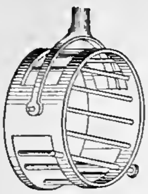
Firemen's Apparatus.

The illustration shows the firemen's apparatus of old time, — buckets, fire-hooks, hammer, and squirt.

Fire-cage. A skeleton box or basket of iron for holding lighted fuel. A *cresset.*

The form illustrated was invented by Dr. Franklin. The cage turns upon axes supported by a crotchet fixed on a stem. The stem may set in a step in the hearth, when used as a domestic grate,

Fig. 1987.



Fire-Cage.

or the fire-cage may be used for a beacon light. The fuel is introduced after withdrawing the upper bar, and when the kindling on top has begun to burn well, the cage is upset, bringing the lighted kindling to the bottom.

Fire-cham'ber. (*Puddling.*) The chamber at the end of the puddling-furnace, whence the flame passes to the reverberating chamber where the charge is placed.

Fire-cock. A street plug for attachment of hose for extinguishing fire, or for other municipal purposes.

Fire-damp A-larm'. One which indicates the presence of dangerous quantities of gas or fire-damp in coal workings. A *gas-alarm* or *gasoscope.*

Fire-dog. An ANDIRON (which see).

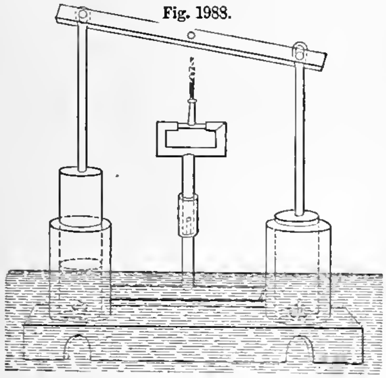
Fire-door. The door of a furnace ; feeding and stoking are usually performed at the opening.

Fire-en'gine. A form of pump for throwing water to extinguish a fire.

The original fire-engine was probably a large squirt, the piston being worked by manual pressure, the barrel being filled from a tub after each discharge. In this form it existed till a late day.

The oldest known engine is described in the *Spiritalia* of Hero, about 150 B. C., and the description might stand for the ordinary form of hand-engine used at the present day. The drawing is made from

Fig. 1988.



Hero's Fire-Engine (150 B. C.).

the description. The engine had two single-acting pumps worked by one beam by means of brakes. The streams united in a common discharge-pipe passing up a trunk in which was an air-chamber and out at a nozzle which was capable of being presented in any direction.

The fire-brigade of Imperial Rome was a company of six hundred freedmen, organized by Augustus Cæsar, A. U. C. 732. A fire-preventive committee, consisting of seven freedmen and a president of the equestrian order, was organized fifteen years afterwards, say B. C. 7. Augustus gave the form stated to a preëxisting organization.

We do not find in any Roman writer a description of a machine so perfect as that of Hero. The *sipho* of the Romans is referred to by Pliny in a letter to Trajan : he states that the people of Nicomedia were too lazy to put out a fire in that city, and that they had no *sipho.* Strabo alludes to the *siphones,* which it appears were kept in a house, in preparation for accidental fire. Apollodorus, the architect of the bridge of Trajan across the Danube, mentions the *sipho.* Its construction seems to be unknown. Apollodorus recommends a leathern bag of water with hollow canes for discharging-nozzles.

The first notice of the modern fire-engine is in the Chronicles of Augsburg, 1518, which speaks of the "water-syringe useful at fires." They were mounted on wheels, and worked by levers. Similar devices are referred to by Lucar, 1590 ; Greatorix, 1656 ; and Morland, 1670.

The fire-engine of Nuremberg described by Caspar Schott, 1657, was of a different character. It was mounted on a sled 4 × 10 feet, and drawn by two horses. It had a cistern 2 × 8 feet and 4 feet deep, in which were two horizontal cylinders. The brakes were worked by twenty-eight men, and the combined streams from the cylinders issued at a one-inch orifice, and reached a hight of 80 feet.

An English patent appears of the date of 1632 to Thomas Grant, and one to John Van der Heyden (or Heide), of Amsterdam, 1663. He is credited with having brought the machine to the present modern form of hand-engine. The brothers Van der Heyden appear to have been the inventors of the leathern hose in detachable sections.

In 1699, a patent was granted in France to Duperrier for a *pompe portative* for extinguishing fires ; to this Perrault added the air-chamber. Papin also adopted it. Hooks and fire-ladders must be assumed to have been long in use, but come into historic notice about this time. Fire-plugs were laid down in the streets of London in 1710 ; previous to that time the water was carried in buckets and poured into the fire-engine reservoirs.

Much attention was drawn to the matter of fire-engines by the disastrous fire of London in 1666, and an act of Common Council was passed shortly after the event, compelling parishes and incorporated companies to maintain an efficient supply of "*buckets, hand-squirts,* and *fire-engines.*"

If we may judge by the description in Clare's "Motion of Fluids," 1735, some of the features of the Continental engines had not yet been received in England. He states : —

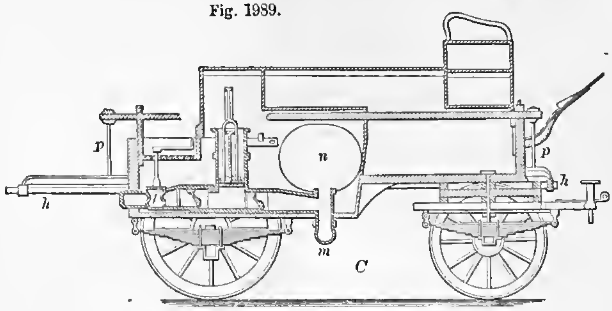
"Engines for extinguishing fires are either forcing or lifting pumps, and, being intended to project water with great velocity, their effect in great measure depends upon the length of their levers and the force with which they are wrought. A common squirting-engine, constructed on the *lift* principle, consists of a large circular cistern, like a great tub mounted on four small solid wheels. A perforated cover was fixed inside the cistern about three feet from the bottom. In the center was fixed a lifting-pump, to the piston-rod of which was attached a cross-tree carrying two vertical connecting-rods, which were simultaneously worked up and down by manual labor by means of handles on opposite sides of the machine. During the downward motion of the piston a quantity of water passes through the valve on to its upper side, and, when the piston ascends, this water is projected with great velocity through a branch pipe provided with a flexible leather joint, or by a ball-and-socket motion, screwed on top of the pump-barrel. Between the strokes the stream is discontinued. The cistern is supplied by water-buckets."

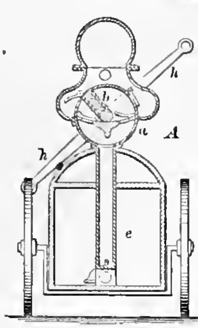
Towards the close of the seventeenth century the double-cylinder portable pump with air-chamber was introduced into England by Newsham ; single-cylinder engines, like the modern garden syringe, being used in France and Germany, and credited to Duperrier and Leupold respectively.

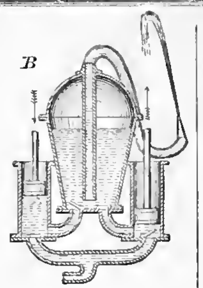
The Newsham engine was improved from time to time, retaining its main features, and was still in use in London till 1832, when it was superseded by a more compact form, which was adapted to be drawn by horses, and from this period dates the efficient fire-brigade system of London.

Newsham's fire-engine was a side-brake double-

Fig. 1989.







Barton's Engine.

cylinder engine, mounted on four wheels, and with an air-chamber, goose-neck, and suction-pipe. The work on the brakes was assisted by men on the box, who threw their weight upon treadles on the pump-levers. Pumps were single-action force-pumps, worked by chains passing over segments on the pump-levers. The engine was perhaps the first successful fire-engine, and Newsham did very well by it. His patent was extended for a second term.

The engine which eventually superseded that of Newsham was made, rather than invented, by Simpkin, and patented in 1792.

The main improvement was in compactness and adaptation to traveling with speed to the spot where its services were demanded. The valves were contained in separate chambers, instead of being placed in the cylinders and air-chamber. By this means they were easily reached, without the disconnection of the main portions of the pump.

Another form of fire-engine was invented by Bramah, 1793, improved by Rowntree and eventually by Barton. The engine of the latter (*A*, Fig. 1989) was on the vibrating principle. To the levers *h h* was attached a radial piston *b*, which oscillated in the cylindrical chamber. As the piston moved in one direction, a valve beneath this piston opened to allow water to pass from the cistern *e*, and the water in front of the piston was forced through the valve-way above it into the air-chamber and passed out at the eduction-pipe to the hose. The difficulty with this engine, as with the rotary steam-engine and other pumps with annular chambers, was to keep the end and sides of the piston effectually packed.

B, Fig. 1989, shows the principle of the modern hand-worked fire-engine, which has two single-acting cylinders with induction-valves in the branches of a pipe which connects with the cistern or water-main; and eduction-valves in pipes which discharge into an air-chamber, whence the water passes by a hose to a nozzle.

C is the English form of hand fire-engine which has brakes *h* on side-levers *p*. The suction is united at *f*, and the discharge is at *m*; *n* is the air-chamber.

Steam-power for extinguishing fires was in use in manufacturing establishments many years before it was employed on portable machines. Every factory of any pretensions had its steam-driven pump, with hose and other attachments calculated to reach every portion of the establishment. About the year 1830, Captain Ericsson, then of the firm of Braithwaithe and Ericsson, London, England, built and exhibited a portable steam fire-engine. In 1842 or 1843 he produced a similar engine in New York City, and it was tested, but never brought into regular service. The engine delivered 9,000 gallons an hour to a hight of ninety feet through a $\frac{7}{8}$-inch nozzle. It was ignited at the station, and drawn by horses to the fire. The time occupied in getting up steam was eighteen minutes. The motion of the wheels worked the bellows to blow the fire in the furnace.

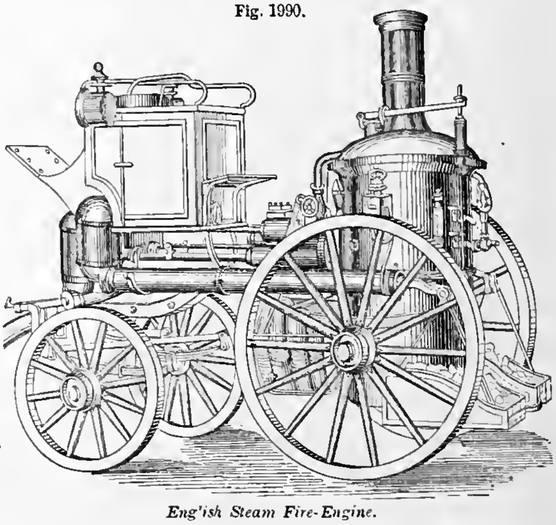
Cincinnati was the first city to adopt the steamer as a permanent portion of its fire-department force.

This was due to the inventive and constructive skill of the brothers Latta and Mr. Abel Shawk, supplemented by the foresight, persistence, and tact of Mayor Miles Greenwood, all of that city.

The metropolitan fire-department of New York City numbers 34 steamers of about 50-horse power each, equal to 185 men, or in the aggregate 6,290 men; while the actual number of men employed, even adding the 12 hook-and-ladder companies, is only about 550; thus relieving 5,740 men from the labors, dangers, and exposure of the fireman.

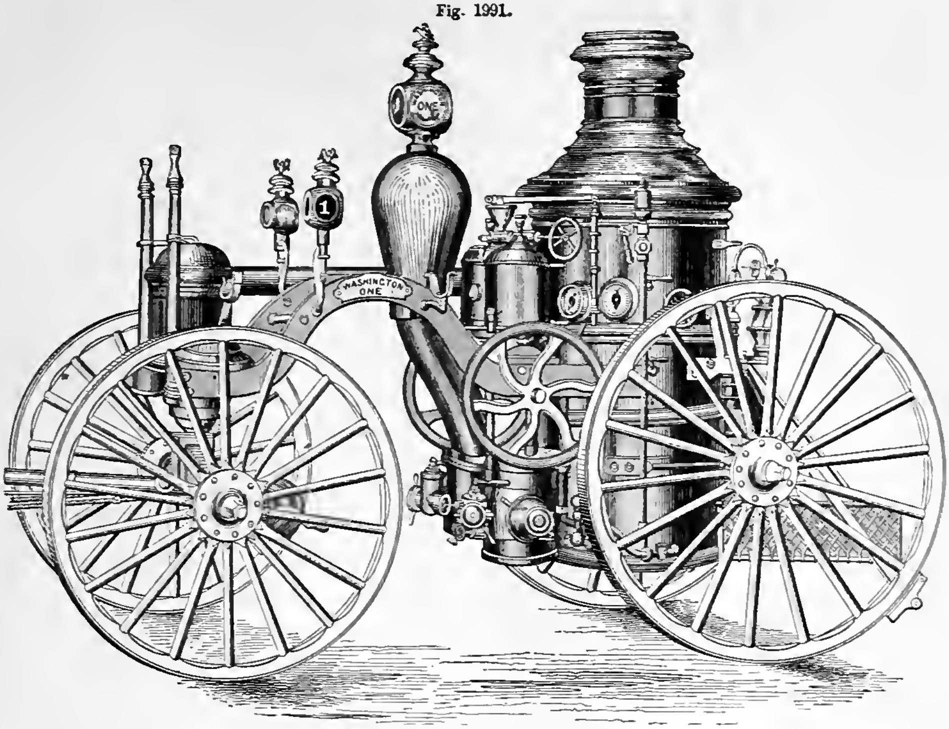
The Cincinnati engines and system are excelled nowhere, and have been copied into the principal cities of the world. The steamer "Citizens' Gift," one of the earliest of the Cincinnati steam fire-en-

Fig. 1990.



Eng'ish Steam Fire-Engine.

Fig. 1991.



American Steam Fire-Engine.

gines, was built in 1853, and thirteen years afterward gave the following record: Time of raising steam, three minutes and forty seconds from the time the torch is applied until water is thrown from the nozzle; size of nozzle, $1\frac{1}{2}$ inches; distance thrown, 310 feet, measuring from the end of the nozzle to the place where solid water fell; size of steam cylinder, 10 inches bore, 24 inches stroke; pumps, 6 inches bore, 24 inches stroke; double engine-cranks at right angles; large air-vessels, connected together; length of hose, 100 feet; steam, 100 pounds to the square inch; pressure on water cylinder, 240 pounds to the square inch; speed of engine, 110 revolutions; 220 strokes of pumps; grate surface, 16 feet; heating surface, 560 feet.

The chemical fire-engine is one on the principle of the fire-extinguisher (which see), in which, by throwing a body of sulphuric acid on to an alkali, a body of carbonic acid is generated and ejected into the flame, usually in combination with a spray of water which is ejected from its reservoir by the pressure of the gas, or by the play of the pump-brakes.

In connection with this subject it may be stated that the rate of insurance by land and sea among the Hindoos was left to the custom of the trade, according to the risk. — *Institutes of Menu* A. D. 880.

Nicholson states that fire-insurance offices were first introduced under the reign of the Emperor Claudius.

The "Hand in Hand" Fire Insurance Company was the first established in London, 1696. The "Sun" Fire Insurance Company was established in 1700. *Marine* insurance had long been common in Venice. The "Amicable" *Life* Insurance Company of London was chartered in 1706.

Fire-insurance offices established in Paris, 1745.

Fire-es-cape′. Fire-escapes are divided into three classes: —

Ladders.
Portable escapes.
Carriage-escapes.

1. Fire-ladders are made of several lengths, to reach second, third, or fourth story windows, and are mounted on a suitable carriage for transportation. The upper ends are usually provided with hooks which catch against the building, on a window-sill, cap, coping, or cornice, and give some degree of security to the ladder.

Another form of the ladder is made of several sections, which may be united to form a ladder of any length required. The sections are united by tubular sockets or clasps.

Another form is that in sliding sections of gradually decreasing width, so that when packed the different sections form a nest of parallel lengths. The sections are slipped on each other by cogs and pinion or by tackle.

2. Portable escapes are those which are contained in a compact form to be raised and placed in position in an emergency.

Among these are —

A *knotted rope.*

Rope-ladders kept within the house and provided with a means for lashing to some stationary object in a room or on a staircase, while the ladder itself depends from the window,

Wire or *chain ladders*, on the same principle, are compact and strong, not subject to decay or to be burned away when in position.

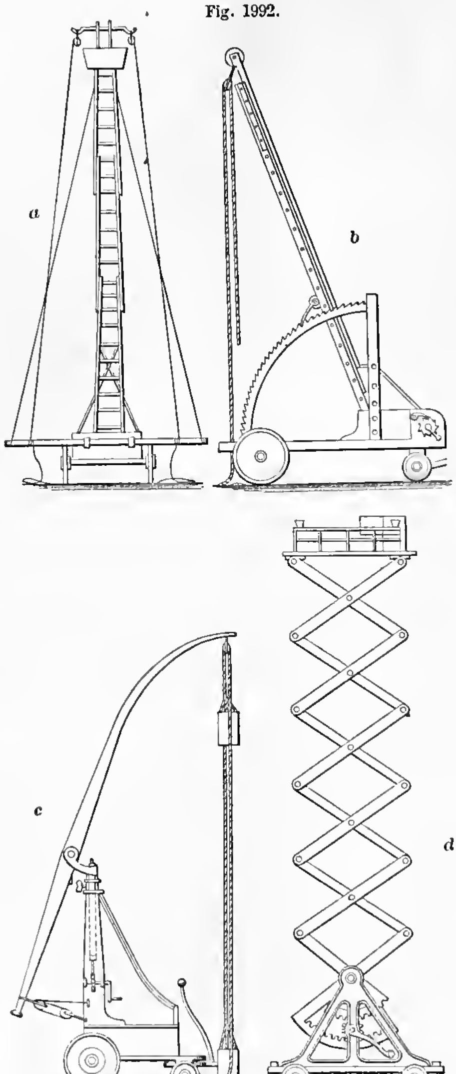
Both descriptions of ladders are also made with grapnels, so arranged as to be elevated from the outside and attached to a window-sill for the escape of the occupants of the house.

Slings are used, and forms of tackle.

One sling has the bight of the rope secured beneath the window-sill and the ends held apart by persons in the street. A clasp is buckled to the person and slides on both ropes, the descent being checked by the divergence of the ropes.

Of forms of tackle, one is the single whip, the person sitting in a sling at one end and veering out the fall through his hands. In another form the person sits in a sling suspended from the bight of a rope, and lowers himself by allowing the rope to veer through the holes of a block, like a euphroe. It is a tackle with dead-eyes instead of sheaves. It is mentioned in Rees's Encyclopedia.

Fig. 1992.



Fire-Escapes.

The Edinburgh (Scotland) fire brigade is furnished with cross-bows and three-ounce leaden bullets to which are attached fine cords 130 feet long. The bullet is fired over the house, and persons in the rear of the building pull at the cord to raise a stronger one from which a chain or ladder or escape is suspended. The men are regularly trained to the exercise.

Of carriage-escapes four types may be cited, but room cannot be spared for a treatise. They may be called the *extension-ladder* with guys and stays, *a*; the *ladder with segment rack*, *b*; the *boom* or *crane*, *c*; and the *lazy-tongs*, *d*. The cuts will be understood without lengthy description.

Fire-ex-tin′guish-er. A portable apparatus for extinguishing fires either by ejection of water, saline solution, or carbonic-acid gas.

1. The vessel contains chemicals whose reaction, when brought into contact, releases a gas which presses upon the surface of the water and ejects it at the nozzle.

a. The chemicals may be contained in two chambers; inversion of the apparatus or the breaking of a bottle of acid mixes the ingredients, and the chemical reaction evolves a gas which presses upon the water.

b. The chemicals may be mixed in the water and generate the pressure which is immediately available when the nozzle is opened and air admitted.

c. The water is saturated with gas, in the manner of the soda-fountain, so as to forcibly expel the water when the outlet is opened.

d. A body of mechanically compressed air is contained in a compartment of the vessel, and is admitted to the water, when required, by turning a stop-cock.

2. *a.* The receptacle contains two vessels, one of which is usually a salt and the other an acid.

When it is to be brought into play a plug is driven in, which breaks the bottle containing the acid and allows it to flow over the salt of soda, potash, magnesia, or ammonia, as the case may be, the evolved carbonic-acid gas flowing in volumes from the nozzle of the vessel.

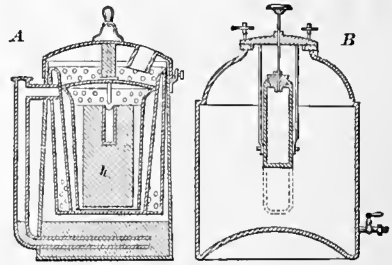
The acid used is usually sulphuric, but hydrochloric and tartaric are occasionally employed.

The salt is a carbonate of an alkali; soda, potash, ammonia, or magnesia being employed, as just stated. Other combinations of salts, chlorides, and sulphates, are employed.

In some of the apparatus, water is ejected along with carbonic acid; in others, sufficient heat is generated to evaporate the water, and steam is ejected with the gas.

b. The vessel contains inflammable substances which generate carbonic acid when air is admitted, and eject the gas in volumes.

Fig 1993.



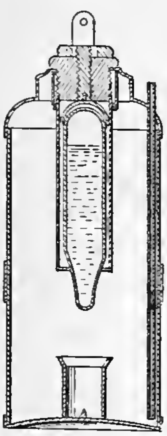
Fire-Extinguishers.

The chemicals used are phosphate of lime, nitrate and chlorate of potash, carbon, sulphur, and various other materials in a multitude of combinations.

There are perhaps sixty patents for various forms of the *fire-annihilator*. The devices particularly refer to the modes of construction, the acid and alkali chamber, the modes of precipitating the former upon the latter and availing the product. The Phillips *fire-annihilator*, so called, patented in 1849 and shown at *A*, has a compound of sugar and chlorate of potash so placed as to receive the contents of a bottle of sulphuric acid which is broken by striking a plug on the top of the can when a fire occurs. The mass of salt and sugar *h* is in the inner chamber, and the vial of acid imbedded in it, so as to be broken by a blow on the central plunger, when the lid is taken off for that purpose. Around the perforated case containing the filling *h* is another one, and that is in a third, between which and the outer one is a body of water. The carbonic acid produced by combustion passes out of the top of the machine, meeting, on its passage out, with the water which is raised in the side pipe by the pressure and heat of the combustion in the can, thus saturating the gas.

The — so-called — *American* fire-extinguisher has a cylinder containing bicarbonate of soda in solution, and an interior tube, containing crystallized tartaric acid, the whole being hermetically closed, but a communication left at the bottom of the tube, through which a reaction takes place, gradually converting the bicarbonate into tartrate of soda, and liberating the carbonic acid. This reaction being complete, the apparatus is ready for use, and on opening a cock at the bottom, the contents can be violently ejected through a short hose.

Fig 1994.



Fire-Extinguisher.

The *Gardner* consists of two cylinders, in one of which is diluted sulphuric acid, and in the other the aqueous solution of bicarbonate of soda. When the apparatus is required for use, connection is made by opening cocks between these two cylinders and a drum below them, into which the liquids flow, and where the carbonic acid is liberated, and the necessary pressure acquired to throw a jet through the hose.

The machine shown in Fig. 1994 contains acid in a glass bottle, which is shattered by dropping upon a stud when forced below the flanges of the tin cylinder which holds it.

The *National* has a glass tube which contains the sulphuric acid. It is protected from accidental shocks by a metallic tube which surrounds it, and which is perforated to permit the free passage of liquid through its walls. When the apparatus is to be used, a piston is screwed down upon this glass vessel, crushing it, and permitting its contents to escape.

The *Babcock* (*B*, Fig. 1993) contains the sulphuric acid in a leaden bucket, hung upon trunnions below its center, so that, if set free, the bucket immediately turns upside-down. It is kept rigidly upright, however, by a stopper attached to a rod passing through the cap of the apparatus. This stopper also completely prevents communication between the acid and the alkali. When the extinguisher is to be used, the stopper is pulled up by means of an exterior handle; the bucket instantly turns over, and empties itself into the liquid in the cylinder.

In another form, the machine is set in operation by tipping. Another is set in action by a fuse tipped with a substance ignited at 120° F., or some other degree, as may be thought desirable. The apparatus is mounted on a carriage to operate on a larger scale.

A different description of fire-extinguisher consists of an arrangement of pipes throughout a building, so arranged as to throw water into the apartments and on the walls, when the water is turned on. With some of these arrangements the water is contained in cisterns on the roof; in others the pipes are connected with the water-distributing mains of the town.

An early instance of the kind is the English patent of Sir William Congreve, dated February 7, 1809, and No. 3201. In it almost all the more modern devices of this kind are shown. The perforated pipes run along the cornices and ceilings, the showers or jets proceed from center to circumference and conversely. On the chandelier pendant rotates a rimless wheel whose spokes distribute jets of water.

The apparatus is actuated by the heat of the room by means of fusible matters, such as wax which melts at 92° F., or a trinary alloy of lead, tin, and bismuth, which melts at 190°. An arrangement is also described by which the rising of the column in the mercurial thermometer is made to set the apparatus at work.

The general discharge may be made by a person in any one of the rooms of the building so furnished.

A common form has a cistern on the roof, central vertical trunk, and radiating pipes with jet-holes. See Fig. 1982, under FIRE-ALARMS. Modern patents concern mere details.

Fire-fan. A small blast apparatus adapted to a portable forge, or one — say a locksmith's — which has small proportions.

Fire-gild'ing. The mode of gilding in which the gold is put on in the form of an amalgam and the quicksilver afterward driven off by heat.

Fire-guard. A wire frame placed before an open fire to arrest sparks and burning coals. See FENDER.

Fire-hook. 1. A large hook on the end of a pole for tearing down buildings on fire, or to arrest a fire.

2. (*Steam-engineering.*) A kind of hook for raking and stirring the furnace fire.

Fire-i'rons. The implements for tending a fire. Poker, tongs, and shovel.

Fire-lad'der. These were introduced, as a part of the machinery for extinguishing fires, about 1672. They seem to have originated in the Netherlands.

Many and ingenious have been the devices for enabling the firemen to reach the scene of conflagration, and to pour in the jet of water at close quarters or into a part of the building which cannot be reached from the ground. Experienced men seem now to have settled down upon a set of ladders of varying length for different occasions, and mounted upon a long carriage drawn by a pair of horses.

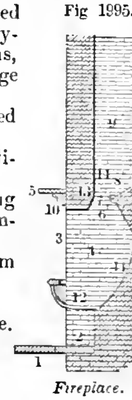
Some forms of ladders are cited under FIRE-ESCAPE (which see).

Fire-lock. A musket or military rifle. See FIRE-ARM.

Fire-pan. A pan for holding fire. The pan which held the priming of the old flint-lock gun.

Fire'place. That part of a room in which the fire is built.

Fig 1995.



Fireplace.

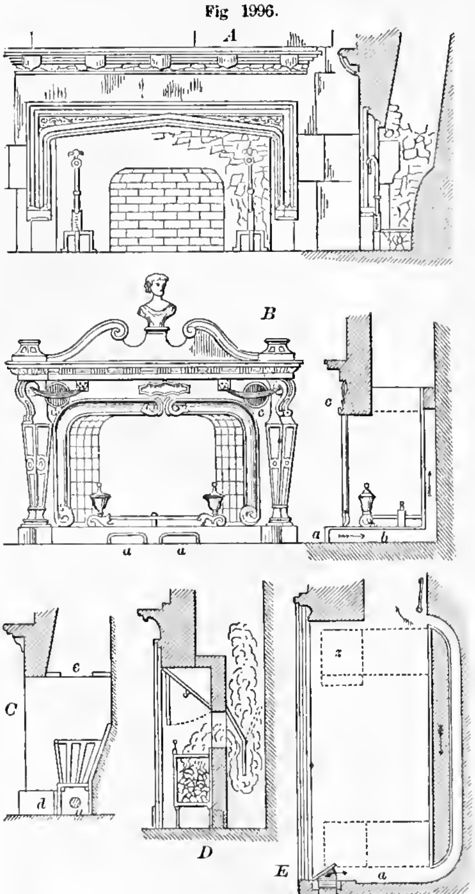
1, slab.	5, mantel-piece.
2, hearth.	6, throat.
3, jamb.	7, gathering.
4, fireplace.	8, funnel.

9, flue. 12, grate.
10, mantel. 13, breast.
11, back. 14, damper.

The earliest example of a fireplace cited in this work is that of Coninsborough Castle, in England, of the Anglo-Norman period. The mantels are constructed of flat arches. The example is adduced to show the earlier form of chimney, and perhaps the most ancient one in existence, anticipating by several centuries the first chimneys erected in Italy. (See CHIMNEY.) The fireplace (*A*, Fig 1996) in the hall of Vicar's Close, Wells, England, is an example of the fireplace of some centuries back.

Louis Savot, of the Faculty of Medicine at Paris (1579-1640), published a work on warming and ventilation in 1624. His is the first recorded attempt at combining the cheerfulness of an open fire with the economy of an inclosed stove. Fig. *B* shows a front view and an elevation of his ingenious arrangement. The hearth, covings, and back were lined with thick iron plates three inches distant from the masonry. Air entered at *a*, passed along the chambers *b*, and entered the room at *c c*.

Fig 1996.

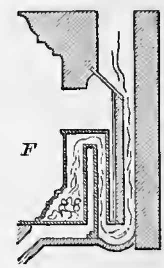


Fireplaces

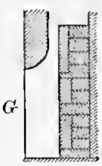
D is Prince Rupert's fireplace, somewhat celebrated in its time. It had a diving flue and false fire-back.

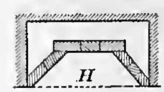
About 1658, Sir John Winter invented a coke furnace or fire-cage (*C*) which was placed on a close box about eleven inches high, in front of which was an opening *d*, fitted with a door, which always kept closed except when the ashes were being removed. A pipe *a* communicated with the external air, and was closed, when required, by a damper. When the valve was opened, a brisk draft urged the fire. The flue was closed by an iron plate or register at *c*.

Fig. 1997.



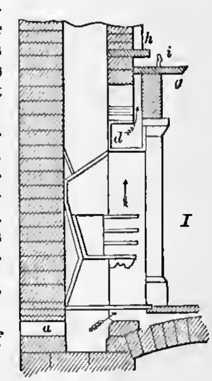
Cardinal Polignac, in 1715, published under the name of another man (Gauger's "Treatise on the Art of warming Rooms") an account of improved mechanical arrangements for fireplaces. This is shown at *E* in the figure. The hollow metallic case forming the back of the chimney is divided into three or more caliducts which are not in contact with the back wall. The jambs are iron plates, solid backed. The channel *a* conducts the external air into the caliducts, which form a fire-back, and the warmed air escapes into the room at *z*. He also introduced the parabolic sides.





Rumford contracted the fire-chamber and throat, and inclined the jambs. See COVING.

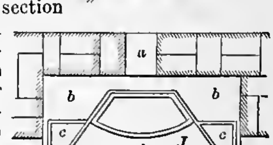
In 1745, Dr. Benjamin Franklin introduced a fireplace which he named the "Pennsylvanian," in which Prince Rupert's descending flue was combined with Polignac's caliducts. This is shown at *F*. (Fig. 1997.)



Count Rumford's improvements consisted mainly in the contraction of the chimney at the throat, the rounding of the breast-work, and the flaring of the covings, as illustrated in the accompanying plan and section *G H*. He preferred an angle of 45° for the covings.

Arnott also made himself a name in this line.

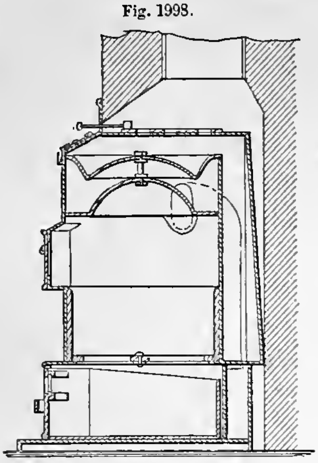
I J are a vertical section and plan showing an English tubular fireplace designed to warm a current of pure air derived from the outside, and direct it into the interior of a room; the air passes from the flue *a* to the under side of the hearth-plate *b* (shown in the plan), thence upward through the upright tubes at *c c* to a horizontal tube *d* (shown in the elevation), which has an opening through its entire length on the upper side, whence the hot air passes into the room, through the aperture *h i* over the mantel. The supply of air may be regulated by moving the strip *i* — which directs the air upward — nearer to or farther from the ledge *h*.



Fireplaces.

Fire'place Heat'er. A stove or closed grate set within or principally within the fireplace, and

Fig. 1998.

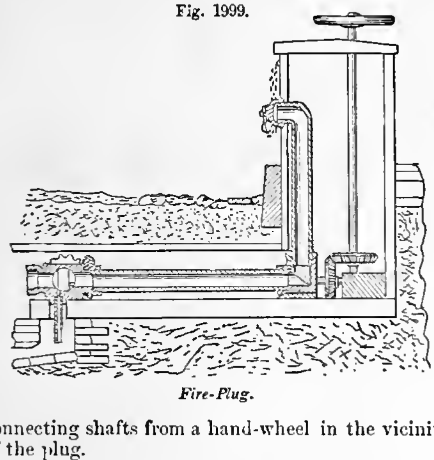


Fireplace-Heater.

serving to warm the room, the pipe discharging into the chimney. The kind known as the Latrobe is a base-burning fireplace-heater whose pipe passes up the brick flue to heat the air which passes between the pipe and the flue to the rooms above, into which it passes through registers.

Fire-plug. A device for connecting a fire or watering hose with a branch from a main. It usually consists of a screw nozzle to which the hose may be coupled, and a key and rod by which the valve is moved. In the example, at the point where the branch pipe is coupled to the main, the stop-cock is placed, and it is operated by gearing and

Fig. 1999.



Fire-Plug.

connecting shafts from a hand-wheel in the vicinity of the plug.

Fire-pot. 1. The box or pot in a stove which holds the fuel. Especially applied to a frustum of a hollow cone or conoid, used in base-burning and other heating stoves (which see).

2. A crucible. In various metallurgic operations the crucible is always termed the *pot.*

Fire-proof Fab′ric. The term *incombustible cloth* was originally applied to fabric made of asbestus, which was used among the ancients to a considerable extent. See ASBESTUS.

Cloth or wood impregnated with certain saline substances will not blaze. Borax, alum, and phosphate of soda or ammonia are recommended as most suitable for this purpose.

By treating cloth with graphite in a bath in which the mineral is suspended, and then subjecting it to the action of the electro-metallic bath, the cloth may be coated with metal.

The chemists who experimented on this subject by direction of Queen Victoria recommend "a concentrated neutral solution of tungstate of soda, diluted with water to 28° Twaddell, and then mixed with three per cent of phosphate of soda." Tissues dipped in this fluid may char or shrivel, but they will not blaze.

Woolen and ordinary stuffs may be treated with borax, alum, or soluble glass, but these cannot well be applied to the lighter descriptions, which are most liable to take fire.

A weak solution of chloride of zinc has long been employed by stage-dancers to render their dresses incombustible. M. Lunere recommends adding to the starch with which the material is done up, half its weight of chalk, and M. Patua proposes a solution of 4 parts borax and 3 sulphate of magnesia, in 20 to 30 parts water. By a new process, equal parts of chloride of calcium and acetate of lime are combined, forming crystals, which is mixed with the starch used in stiffening.

Though not strictly coming under the denomination of fire-proofing, an interesting fact is stated by M. Corne in a communication addressed to the Academy of Natural Sciences, that by previously dipping the hands in liquid sulphurous acid, they may then be immersed in melted lead or iron with perfect impunity. This is owing to the extremely volatile character of the acid, which has been made use of in the curious experiment of freezing water in a red-hot crucible.

Fire-proof Safe. One for the safe keeping of valuables for protection in case of the burning of a building in which they are placed. See SAFE.

Fire-proof Struct′ure. A vault, safe, or building proof against destruction by fire, either from the outside or by the burning of its contents.

The provision against outside fire is the usual object, but in fire-proof structures the internal floors or partitions must also be impenetrable by fire, to make the building technically *fire-proof.*

The principal portions of a building are the walls, floors, and roof, and several modes of constructing each have been proposed, to the end that they may be secure from fire.

The term *fire-proof building* is somewhat loosely applied, and may be held to mean, —

A building absolutely incombustible, such as one whose walls, floors, and roofs are of metal, stone, brick, or cement.

A building capable of opposing the access of fire from without, having walls, window shutters, and roofs which are incombustible from external flame and heat.

Among the first instances may be cited some government buildings, whose walls are of stone and brick, ceilings and floors of brick arches and pavement; or of metal, brick, and cement; rafters and roof-covering of metal, or metal and slate.

The Bogardus buildings of cast and wrought iron, and the Paxton buildings of iron and glass, are other illustrations of fire-proof structures, unless the amount of combustibles contained should be such that their conflagration will melt or crumble the material of which the building is constructed. Such was the case with a part of the Crystal Palace at Sydenham, the internal fittings of that portion, the louver boarding, and the furniture making a bonfire which melted the skeleton frame. Iron buildings in serious external fire exposure, or with combustible contents, are far from deserving the name of fire-proof, though they may resist a certain amount of scorching.

The usual mode of making fire-proof floors is to construct girders and beams of iron (see BEAM), supporting flat arches of brick, as in the U. S. Treasury, Medical Museum, and other government buildings, or of a pavement of stone slabs resting on flanges of the beams. The ceiling in such a case may be of plaster on lath made of hoop-iron or wire-work riveted to the beams. See FLOOR; LATH.

Many European buildings are thus constructed, being filled above the arches with incombustible rubbish, and the tiled floor laid in cement thereupon.

Besides the projects for rendering materials fire-proof, a number of plans have been devised for adding to the security of a building, although the structure cannot be considered as actually *fire-proof*. Some of these may be mentioned.

The floors of some Edinburgh houses are of plank two and a half or three inches thick, grooved and tongued to each other or united by a fin of metal forming a tongue which runs the entire length. The planking is fitted air-tight to the walls, the object being to prevent the passage of fire, and depend upon the thickness of the flooring to hold fire at bay in a given part of the building, until the usual means of extinguishing it can be brought to bear. It is laid on iron joists. Cement on the upper and lower surfaces adds to the security. This is an excellent plan.

Another plan is to form the floors and roofs of hollow earthenware tubes and cement, resting upon joists or rafters, as the case may be. The tubes are made square in section. The floor has about one fifth the weight of stone. Frost's cement of levigated chalk, 2 parts; clay, 1 part; dried, broken, burned, and ground to powder. This is an approach to the pozzuolana, and is mixed with twice its quantity of sand and water, sufficient to form a mortar. See CONCRETE; CEMENT.

There are various concretes which may be made into slabs, capable of resting upon iron beams at the usual distance, and thus form a perfectly fire-proof floor.

It should be mentioned as an imperative necessity that the staircase should be absolutely incombustible, of metal or stone, or the two combined.

When a building has some of the *protections* against fire, without being absolutely *proof*, the stairs and hatchways must be inclosed in such a manner as not to be involved by a fire breaking out on any of the floors. Otherwise the vertical shaft forms the best possible means of communicating fire from one portion to another, especially if the fire be low down in the building.

Other plans are, —

Iron facing for walls; secured by anchors or studs. Iron skeletons filled with brick or concrete. Concrete or béton walls. Hollow tile walls. Iron frame with wire-work riveted thereto and covered over with plaster or concrete. See WALL, where many varieties are illustrated.

The means for fire-proofing the necessary openings, that is, the door and window ways, are by louvers, folding, sliding, swinging, and rolling shutters of iron. Some made double with intervening air-space; others made to close automatically by the increase of heat when exposed to fire.

Hartley's patent, 1775, consisted of a plan for sheathing wooden work with thin iron plates.

Earl Stanhope's plan was to pack all the inter-spaces of wood-work with incombustible material; preferably concrete.

Of other English plans of late date may be cited, iron joists with concrete filling and upper bed supporting the flooring. See FLOORING, where several varieties are shown.

Another plan is cellular joists of earthenware tubes imbedded in cement.

Loudon recommends a floor of cement with imbedded ties of wrought-iron rods, supported by pillars at intervals; and double sides of concrete supported by panels or lattice, leaving intervening spaces between walls.

In large fires, cast-iron is found to be a treacherous and destructible material, as was proved in Chicago, Boston, and elsewhere, fairly melting in the fire. Mr. Braidwood, of the London Fire Department, stated that iron columns were liable to give way suddenly, owing to the expansion and contraction by heat and jets of water. Mr. Mullett, the supervising architect of the Treasury Department, indorses the statement, and prefers sound oak timber to cast-iron, especially if it be treated with a liquid silicate.

Fire-proofing by rendering the timber of the structure incombustible has been frequently attempted. Payne's process consists of immersion in a solution of barium or calcium. Professor Fuchs of Munich recommends as a material for rendering wood fire-proof a composition of potassa or soda, 10 parts; siliceous earth, 15 parts; charcoal, 1 part, fused and formed into a water-glass and applied in solution. It forms a vitreous coating.

An English composition is as follows: Fine sand, 1 part; wood ashes, 2 parts; slaked lime, 3 parts. Grind in oil, lay on with a painter's brush, the first coat thin and the next thick.

Fire-proofing may be said to be accomplished when — 1, the building is of a material which neither burns, melts, cracks, nor crumbles with the heat. Well-made, homogeneous, and well-burned bricks are the best. Granite, marble, and sandstone perish by the heat.

2. Every opening communicating with the external atmosphere must be kept closed with fire-proof doors and shutters, not iron merely, which will buckle up, warp, and melt.

3. The walls must be of sufficient thickness, and should be built with an air-space to prevent the transmission of heat.

4. The joists should in no case be carried into the walls, but should be supported on corbel courses of brick, and connected with the walls themselves only by wrought-iron anchors.

5. The windows and doors to be protected, as before said, with fire-proof shutters, and the roof to be of slate or metal. The use of roofs composed of shingles, coal-tar, or other similar substances, should be prohibited by law in cities.

6. An isolated stone or iron staircase should reach every story, having fire-proof doors at each floor, and a line of water-pipes communicating with the mains in the streets or a cistern on the roof.

7. Partition-walls between houses rising above the roof. In the case of warehouses, as few openings through the party wall as possible, and these capable of being closed effectually.

A refinement upon the brick construction consists in using fire-brick with joinings of fire-clay, instead of mortar or cement; and the isolation of rooms instead of floors only is recommended in a report to the London Society of Arts; farther, to have no opening into the rooms except to external fire-proof corridors on each story; ascended by circular stairways. Doors, shutters, as well as walls, floors, and roof, to be of fire-brick, making each room an hermetically sealed vault.

For the purpose of extinguishing fire in any of the apartments, it is proposed to lay tubes of fire-clay in the spandrels of the building with small jet tubes, or pipes, commanding each room or corridor of the whole warehouse, so that the water can be turned on to any part required, to flood if necessary the entire room. In such case the water would run down the walls to the floor, where, by a system of pipes leading to the main sewer, the proper drainage would be effected. It is also proposed to open and shut all the doors and shutters, and work all the cranes by machinery in another building to be under the supervision of a watchman, properly instructed, and competent to see that the system is in working order at all times. The same system of piping used to extinguish fires may also be used to cleanse the rooms, as occasion may require.

This system of protection against loss by fire, or rather mode of overcoming fire, by abundant ramifications of water-pipes throughout all the apartments and passages of a house, as well as upon the roof and walls, is thoroughly described in Sir William Congreve's English patents, No. 3201 of 1809, No. 3606 of 1812, and there seems but little to be added to his proposals where jets are by the turning of a plug caused to issue from center-piece, cornice, skirting-board, eave, comb, gable, and everywhere else. As this was before the era of water-mains, except in a few situations, the proposed supply was brought from cisterns on the roof or from pumps, and each floor or gallery had plugs by which the system of pipes of the respective stories were supplied.

A large flax-manufactory, to be run by steam-power, was erected about 1790, by Mr. Bage, at Shrewsbury, England. It was four stories high; the floors of brick arches were supported on cast-iron columns. The roof was also of iron.

Fire-reg'u-la'tor. A thermostatic device to open or close the access of air to the fire, or to govern the draft-area in the chimney, in order to urge or moderate the fire as it may sink below or rise above the desired point to which the thermostat is adjusted.

Fire-screen. 1. A fire-guard or *fender*.

2. A screen to place between a person and the fire to intercept the direct rays.

Fire-shield. A portable structure on wheels or on legs, used to protect a fireman on duty from the heat of a burning building, or to isolate a fire and prevent its spreading to adjacent buildings. It is usually a screen of sheet-iron supported by posts and stayed by guys.

Fire-ship. A vessel freighted with combustibles and explosives, and turned adrift so as to float among the vessels of the enemy, against a bridge or other object which may be burned by the fire or destroyed by the resulting explosion.

Fire-ships were used at the siege of insular Tyre.

By the Rhodians against the Syrians, 150 B. C.

In the action near Carthage, when the fleet of Basilicus was destroyed by Genseric.

In the naval warfare of the Knights of Malta and the Turks.

At the siege of Antwerp, 1585. By Sir Francis Drake against the Spanish Armada, 1588.

By the Greeks against the Turks, 1826.

The Chinese against the English in the villainous opium-war.

In 1760 they formed a regular portion of the British navy. As a distinct class of vessels, they are now discontinued.

They are particularly serviceable in defence and in attacking ships at anchor, and besides the skillful but ineffectual use of them by the Chinese, the instance may be mentioned of the fire-rafts which were launched by the Confederate forces against the approaching fleet of Farragut as he forced the passage of the Mississippi.

Fire-steel. A steel used in connection with a flint for striking fire.

Fire-stop. The fire-bridge at the back of a furnace; so called because it prevents coals being pushed over.

Fire-sur'face. (*Steam-engine.*) The area of surface of the boiler which is exposed to the direct and radiant action of the flames.

The heating-surface of a boiler is made up of the *fire-surface* and *flue-surface*.

With an average boiler 15 feet of heating-surface of the boiler are allowed for each horse-power. The Cornish engine has a much larger heating-surface per horse-power; as high as 60 feet being sometimes allowed.

The locomotive has a smaller heating-surface per horse-power, a more intense fire being kept up and less economy of fuel being practiced.

Fire-tel'e-graph. See FIRE-ALARM TELEGRAPH.

Fire-tube. (*Steam-engine.*) A furnace-tube through which the flame and heated air pass from the fire-chamber. A *flue*; a *pipe-flue*; or *flame-tube*.

Fire-work. The Chinese led the world in this line in point of priority, and perhaps do yet in quality. Fire-works are said to have been first used in Europe by the Florentines, and are mentioned as a part of the pageant at the marriage of Henry VIII. and Anne Boleyn. They were not common during the reign of Elizabeth, but came into popular use during the reigns of the Stuarts.

Marcus Græcus, in a treatise on pyrotechny (*Liber Ignium*) published about A. D. 825, describes the nature of the composition for making fire-works.

The bearing of fire-works on the invention of fire-arms is referred to in the article on GUNPOWDER (which see). See list under PYROTECHNICS.

Fir'ing. 1. (*Furnace.*) The mode of introducing fuel into the furnace and working it.

Hard-firing; charges in quick succession with frequent stoking.

Heavy-firing; large charges of fuel and frequent stoking. Known also as *close*-firing, *thick*-firing, and *charging*, from the large body of fuel introduced at a time.

Light-firing; moderate and frequent in quantity; coking the charge on the *dead-plate* and then pushing it on to the coals. Also called *open*-firing, as the charge is thinly spread on the grate-bars and the draft is free.

2. (*Glass.*) The process of fixing the colors upon glass. The colors are metallic oxides, ground up with flint glass and borax, and laid by a paint-brush upon the pieces or sheets of *crown-glass*. These are then removed to the kiln, where the colors become fused and unite inseparably with the surface of the glass on which they are laid, the flux enabling the color to melt before the glass plate becomes distorted by the heat. The *crown-glass* being a silicate of potash and lime is much more intractable than a glass into whose composition lead enters. See GLASS-COLORING; GLASS-PAINTING; GLASS-STAINING; ENAMEL.

Fir'ing-i'ron. A farrier's cautery.

Firm'er-chis'el. A chisel, usually thin in proportion to its width. It has a *tang* to enter the handle, in contradistinction to the *framing*-chisel, which has a socket into which the handle fits.

Firmer-chisels are usually eight or twelve in a set of different widths. They are shorter than *paring*-chisels and lighter than *framing*-chisels.

First-coat. (*Plastering.*) The primary coat of coarse-stuff. That of two-coat work is called *laying*, when executed on lath, and *rendering*, when on brick.

The first coat of three-coat work is called *pricking-up* on lath, *roughing-in* on brick.

Fish. 1. A strengthening or stiffening bar laid alongside another; as —

The *fish-bar*, which splices the ends of adjacent railroad rails and decreases the tremor or depression at the joint. See FISHING.

One of a pair of bars laid on opposite sides along and tightly lashed to a spar which has been sprung. See SPLICE.

2. A purchase for hauling in on to the gunwale the fluke of an anchor.

Fish-bar. The splice-bar which breaks the joint of two meeting objects, as of railroad rails or scarfed timber. See FISHING.

Fish-beam. A beam with a bulging belly.

Fish-bel'lied. Bellying on the under side, as a beam, a rail, etc.

Fish-block. (*Nautical.*) The block of the fish-tackle for raising the anchor.

Fish-da'vit. (*Shipbuilding.*) A spar or small crane projecting from the bow of a ship for the suspension of the tackle, called the *fish-fall*, used in hauling up the arms of the anchor in getting it aboard. The fish-davit is such a distance abaft the *cat-head* as the length of the anchor may require, and is used to lift the fluke of the anchor to the bill-board; a roller keeps the fluke from bruising the vessel's side.

In preparing for *letting go* the anchor, it is suspended by its throat from the *fish-davit* by a chain or rope called the *shank-painter*, which is cast loose simultaneously with the *cat-head stopper*, the two being secured *on board* by means of movable pins called *tumblers*, which are moved by a lever and disengage the chains or ropes at the same instant.

Fish'er-man's-bend. A sailor's knot, used in bending halyards to a studding-sail yard. Two turns are taken round the spar, the end passed between them and the spar, and half hitched around the standing part.

Fish-fall. (*Nautical.*) The tackle depending from the *fish-davit* and used in hauling up the *arms* of the anchor.

Fish-flake. A structure on which fish are spread to be air and sun dried.

Fish-front. (*Nautical.*) Curved pieces of timber bound upon the outside of a broken spar to stiffen it and make it serviceable.

Fish-garth. A staked or dammed enclosure on the margin of a river to form a fish-preserve.

Fish-gig. A spear with several barbed prongs used in spearing fish. It has usually five prongs, called *grains*.

Fish-globe. A spherical glass vessel forming an aquarium.

"Thence to see my Lady Pen, where my wife and I were shown a fine rarity; of fishes kept in a glass of water, that will live so for ever, and finely marked they are, being foreign." — PEPYS'S *Diary*, 1665.

Fish-glue. Isinglass.

Fish-hook. Fish-hooks are mentioned in the Bible in several places, in connection with brooks, rivers, and the sea.

The first fish-hooks were made of bones or thorns, the latter being indicated by the root of the Hebrew word.

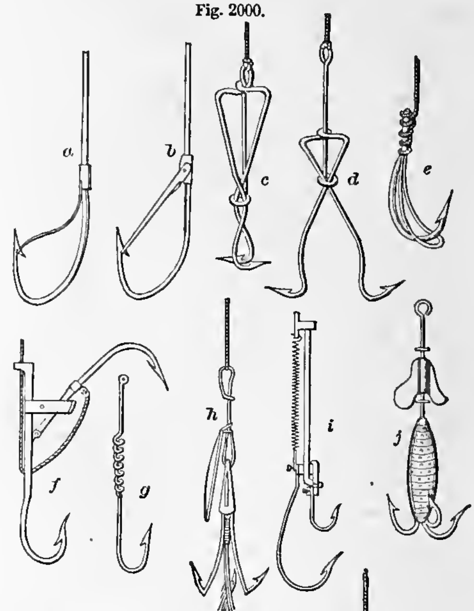
"Canst thou draw out leviathan with a hook" (ancient version, "thorn"), "or his tongue with a cord which thou lettest down?"

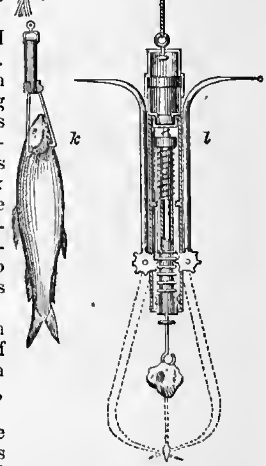
"Canst thou put a hook into his nose? or bore his jaw through with a thorn?" — *Job* xli. 1, 2.

The latter verse bears a peculiar significance, referring to the practice of attaching a fish by a hook and cord to a stake, so as to keep it alive in the water. The crocodile, if it be the animal referred to, would require a hook rather larger than those used by the anglers of the Euphrates, with which river we suppose the patriarch of Uz to have been familiar.

The natives of the South Seas in the regions visited by Magellan, Cook, La Perouse, Anson, and others, made fish-hooks of bone, carved or neatly

Fig. 2000.





Fish-Hooks.

framed together and bound with sinews. Such are common in the museums, along with the bone knives and cutting instruments made of shark's teeth lashed to a back piece, the primitive saw. A mother-of-pearl hook with attached tuft of hair to act as bait is known as *witte-witte*.

The old Egyptian fish-hooks were of bronze. See one in Dr. Abbott's collection, New York.

Homer mentions the "barbed hooks" as used by Ulysses and his companions in Sicily: —

> "All fish and birds, and all that come to hand
> With barbed hooks."
>
> *Odyssey*, XII. 322.

Athenæus states (A. D. 220) that "the hooks were not forged in Sicily, but were brought by them in their vessel." — *Athen. Epit.*, B. I. 22.

Of the Grecian fish-hooks, some were bent around and others were straight, with a barb.

In the cut are shown a number of fish-hooks, of which *a b* are two forms of a spring hook in which a mousing-piece engages the barb.

c d are two positions of the same spring hook, one set and the other sprung.

e is intended to give the hook a square presentation, and prevent glancing of the hook in striking.

f has a tripping hook which strikes from above, and supplements the primary hook.

g has a spiral-spring shank.

h has a spring hook attached to the snood, which affords the means of attaching a bait or other hook.

i has an additional hook, which is sprung, and thus supplements the primary hook.

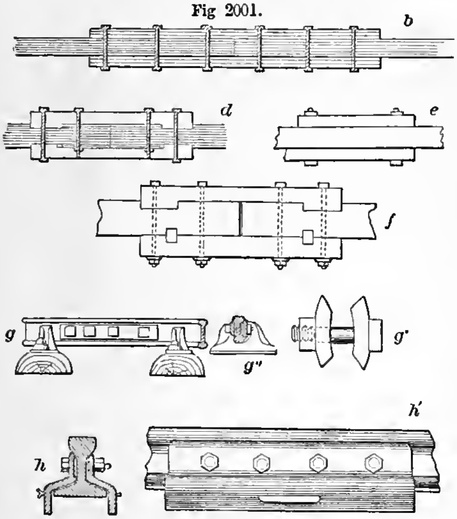
j has spiral vanes, so as to revolve it when drawn through the water in trolling.

k l shows two forms — on different scales — of a spring hook whose claws are thrown down upon the fish which tampers with the bait.

In making the hooks, straight wires of the proper size and length are flattened at one end, and the barb formed by a single blow with a chisel. The point having been sharpened, the proper curve or twist is given to the hook; the soft iron is then case-hardened, to give it the stiffness and elasticity of steel, by immersion in hot animal charcoal. The hooks are subsequently brightened by friction, and tempered. In the hook-making machine, the wire is run from a reel into the machine, and on the other side the fish-hook drops out completed, with the exception that it must be tempered and colored. After the wire reaches a certain point, the requisite length is clipped off. The next operation barbs it; the other end is flattened. It passes around on revolving dies, whose teeth, formed like the notched spikes of a wheel, catch it, and bear it from one operation to the next until it is smoothed and filed, when it passes between rollers that give it the prescribed twist and turn, and it drops into the receiver awaiting it.

Fish'ing. 1. Uniting by clamping between two

Fig 2001.



Fishing.

short pieces which cover the joint. As a compound beam, *b d e*, Fig. 2001.

At *f* is shown a combination of *fishing-pieces*, *coaks*, and *bolts*; the coaks on the lower surface are substitutes for the *indents* of the surface above.

g g' g'' show one form of clasping plate in several views.

The *fish-plate h h'* for railway-rails has a bend which laps upon the foot of the rail, and a drooping flange; the bent form giving a rigidity which strengthens the rail against deflection. The rail is prevented from opening at the joint, or spreading, as is usual with the ordinary fish-joint, whose strength is only equal to one third that of the rail.

2. (*Nautical.*) Lifting the anchor-fluke on to and over the gunwale.

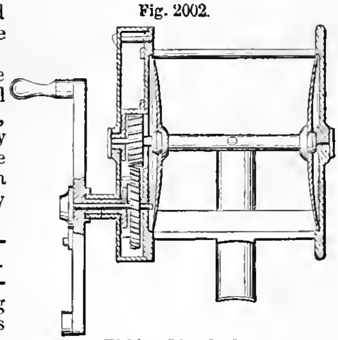
3. Fishing, as an occupation, is perhaps almost coëval with our race. The distinction between netting, trapping, and angling was early understood. "The fishers also shall mourn, and all they that *cast angle* into the *brooks* shall lament, and they that *spread nets upon the waters* shall languish. . . . . They shall be broken. . . . that make *sluices* and *ponds* for fish." (Is. xix. 8, 10.) See also Habakkuk i. 14, 15; Amos iv. 2 (787 B. C.). Oppian wrote a Greek epic on fishes and fishing about A. D. 198. Wynkyn de Worde's "Treatyse of Fysshinge" appeared in 1496, and Walton's "Complete Angler" in 1653.

Fish'ing-line. A flaxen or fine hempen cord for angling.

The Grecian fishing-lines were of horsehair, white nearest to the hook. Horsehair, catgut, and silk are now used for *snoods*.

Fish'ing-line Reel. A little winch, usually attached to a fishing-rod, and upon which the line is wound.

Fig. 2002.



Fishing-Line Reel.

In one case it is furnished with an alarm, so that a sleepy fisher may have notice when a fish runs away with the bait.

Fish'ing-net. See NET.

Fish'ing-rod. Angling for fish was common in ancient Egypt, but they do not appear to have used a float. The line was comparatively short, and the rod in a single length. They used landing-nets. They do not seem to have practiced fly-fishing. Spearing fish, especially with the *bident*, is shown frequently in their sepulchral paintings. The fish-spear was attached to a cord which was wound on a reel.

The hook and fish-spear are mentioned in the Book of Job. Fishing-lines of horsehair are mentioned by Aristotle.

The Grecian fishing-rod was, as now, a reed, — *calamus*. It was not made in jointed sections.

Modern rods are made of bamboo lengths fastened together by telescopic or screw couplings.

Fish'ing-smack. A sloop having a water-chamber in the hold to keep fish alive.

Fish'ing-tube. (*Microscopy.*) An open-ended glass tube for selecting a microscopic object in a fluid. The tube is closed at the upper end by the finger until the lower end is close to the object. The finger being raised the water rushes in, carrying the object with it.

Fish-joint. A plate or pair of plates fastened upon the junction of a couple of meeting portions of a beam or plate. See FISHING.

The fish-joint for connecting railway-rails was first designed by W. B. Adams, England, 1847, and was soon extensively introduced. It consisted of a pair of plates 18 inches long, 3 by ¾ inches, bolted together through the rails by 4 bolts, allowance being made by oval bolt-holes for expansion and contraction of the rails.

The fish-joint with keys instead of bolts was first used (Holley) by Barr of Newcastle, Delaware, in 1843.

In Samuel's fish-joint the bolt passes through a hole in one fish-plate and is tapped into the other. This obviates the nut, which is apt to be in the way of the wheel-flange.

Fish-ket'tle. A long kettle adapted to boil fish of, say, from four to ten pounds' weight, without destroying the symmetry of the fish or cutting it into pieces

Fish-lad'der. A dam with a series of steps to enable fish to ascend the fall by a succession of leaps. See FISH-WAY.

Fish-plate. A plate used to secure together the ends of adjacent rails, to hold them strictly in line, avoiding lateral deflection or sagging. It usually consists of a plate on each side of the joint, clasping the *web* of the rail, and secured by bolts and nuts. See FISHING.

Fish-pot. An open-mouthed wicker basket containing bait, and sunk in the haunts of fish to catch them.

Fish-skin. The rough skin of the dogfish or shark is used as a rasp.

Shagreen is a leather of fish-skin.

The skins of the porpoise, beluga, and seal are tanned.

Eel-skins are used as *whang.*

Sole and other skins are used in making a kind of isinglass for clarifying liquors.

Fish-slice. A broad-bladed silver knife used for serving fish at table. The trowel-shaped blade enables a portion of fish to be removed from the backbone without breaking it into unsightly fragments.

Fish-spear. A barbed spear for catching fish. A *gig.*

Fish-spears are mentioned by Job and by the Greek writers. They had one, two, or more barbed prongs. Neptune's trident was a fish-spear, tridented or three-toothed.

Fish-tack'le. (*Nautical.*) A purchase to raise the flukes of an anchor to the gunwale, for stowage, after being *catted.* A *fish-fall.*

Fish-tail Burn'er. A gas-burner whose burning jet assumes a two-lobed form, like the tail of a fish.

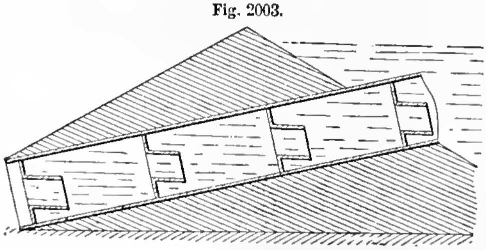
Fish-tail Pro-pel'ler. A single-winged propeller hinged to the stern-post and oscillating like the tail of a fish.

Fish-trap. A box or basket set in a river and having bait slung in a bag to attract fish; it is sprung by hand.

A basket, net, or staked area with a divergent-sided or funnel-shaped opening through which fish pass, and in which they find a difficulty in retracing their course, owing to obstacles or blind sacs.

Fish-way. A device to enable a fish to ascend a fall. It may consist of a series of steps over which

Fig. 2003.



Fish-Way.

the water descends, turning a fall into a cascade, and sometimes known as a fish-ladder; or it may consist of a chute with a sinuous track for diminishing the velocity and assisting the passage of the fish to the level above the dam. In the example, it is an inclined chute having a series of chambers containing comparatively still water, the current being confined to a relatively smaller space.

Fis'sure-nee'dle. A spiral needle for catching together the gaping lips of wounds. By revolution, the point is made to pierce the lips alternately, carrying its thread with it. Tiemann's needle for cleft palate is hollow throughout its length, and carries a silver wire which is left in its place when the needle is retracted by backward rotation.

Fig. 2004.

Fissure-Needle.

Fis'tu-ca. A pile-driver. A *monkey.*

Fis'tu-la. A water-pipe, according to Vitruvius, who distinguishes three modes of conveying water: by leaden pipes, by earthen pipes, and by channels of masonry.

Fit-rod. (*Shipwrighting.*) A gage-rod used to try the depth of a bolt-hole in order to determine the length of the bolt required.

Fix. See FIXING.

Fixed Am'mu-ni'tion. A charge of powder and shot inclosed together in a wrapper or case, ready for loading.

Fixed Light. One character of light displayed from a lighthouse. Its beams are constant, differing from those termed *flashing, revolving,* and *intermittent.* It is susceptible of variation, as *white* or *colored, single* or *double.* See LIGHT; CATOPTRIC-LIGHT.

Fixed Star. (*Pyrotechnics.*) A composition introduced into a rocket-case and emitting fire at five holes, to represent a star. The composition is niter, sulphur, gunpowder-meal, antimony.

Fixed Sun. (*Pyrotechnics.*) A device composed of a certain number of jets of fire distributed circularly like the spokes of a wheel. All the fuses take fire at once through channels charged with quick-matches.

Glories are large suns with several rows of fusees.

Fans are portions of a sun, being sectors of a circle.

The *patte d'oie* is a fan with only three jets.

Fix'ing. 1. (*Photography.*) Of a *negative;* the removal, by a solution of hyposulphite of soda or cyanide of potassium, of the unaffected deposit of iodide and bromide of silver in the collodion film after exposure and development of the picture.

Of a *positive:* the removal of the unaltered chloride of silver from the surface of the photographic paper after exposure under the negative.

2. (*Metallurgy.*) The material used in preparing the hearth of a *puddling* or *boiling furnace* for receiving its charge. A certain amount of ore, cinder, and scrap are banked up around the boshes, the amount and kind varying with the character of the iron and the construction of the furnace. It is called *fettling* in some parts of England, the word *fettle* being provincial English, and substantially the same as our *fix.*

Flack'et. A barrel-shaped bottle.

Flag. 1. A banner indicating nationality, occupation, or intelligence.

Flags of *nationality* are *standards, ensigns, pennants* (pendants), *jacks.*

Flags of *occupation* indicate service, as *war, merchant, despatch, pilot, yacht-squadron, liners,* etc.

Flags of intelligence are of various colors and of three shapes: square (*a*), pointed (*b*), burgee (*c*). They are used in various combinations to transmit messages according to a printed or secret code.

The *standard* (*military* or *naval*) is a *war* flag.

The *ensign* (*d*, American ; *c*, English) is national. It has the *union* in the upper corner next the staff, the other portion of the flag being denominated the *fly*.

In the English service the ensign with a white fly, a red cross, and the jack in the corner, belongs to war-vessels. Other government vessels carry the *red* ensign (red fly).

The *blue* ensign belongs to the merchant service.

The *pennant* (*f*) is a long strip of bunting, and is used to indicate the commodore's vessel, and formerly, in connection with an ensign, to indicate a government vessel of the nationality to which the ensign belongs.

The *jack* is a flag having the *union* of the ensign without the fly. *g*, American ; *h*, English.

An *anvil* is a little narrow flag or pennon on the end of a lance.

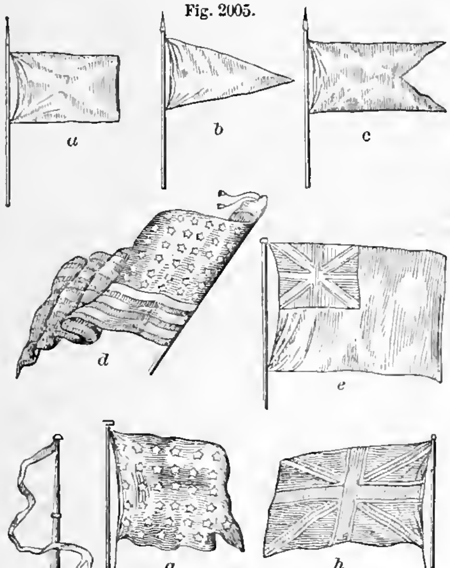
A *banner* is a small flag edged with fringe.

A *bandrol* is a small streamer from a masthead.

A *fanion* is a small flag for a surveying-station ; from the Italian *gonfalone*, a standard.

A *guidon* is a small swallow-tailed flag used in cavalry regiments. One is furnished to each company. See GUIDON.

Fig. 2005.



Flags and Ensigns.

A *streamer* is a relatively narrow flag or pennon.

Flags with special designs are used on particular occasions, as the flag known as "blue-peter" indicates that the vessel is about to sail. It is a blue flag with a white square in the middle. There are many other signal flags, and some to represent numbers, by which messages may be signaled according to a printed code. See Haswell's "Engineers, etc., Pocket Book," p. 149.

The *hight* of an ensign is the *hoist* or *depth*, and is $\frac{10}{19}$ of its length.

The *length* from the staff to the outer edge is the *fly*.

In the United States service, —

The garrison flag has 20 feet head, 36 feet fly.

The storm-flag has 10 feet head, 20 feet fly.

The regimental flag has 6 feet head, 6 ft. 6 in. fly.

Camp-colors are of bunting, 18 inches square.

The *field* has 13 horizontal stripes of red and white alternately, beginning with red.

The *union* has a blue field in the upper corner, next the *head*, four tenths of the length of the field and seven stripes in depth, with white stars ranged in equidistant horizontal and vertical lines, equal in number to the number of States in the Union. See "Army Regulations," ed. 1863, p. 461.

2. A slab of stratified stone for sidewalks, etc.

3. The uneven end of an uncut tuft of hair in a brush.

Flag′e-o-let. (*Music.*) A wooden musical wind-instrument having a mouthpiece and six principal holes which are stopped by the fingers, as in a flute.

The double flageolet is said to have been invented by Bainbridge, and upon it duets may be played. It is mentioned by Pepys.

"To Drumbleby's, the pipe-maker, there to advise about the making of a flageolet to go low and soft ; and he shew me a way which do do, and also a fashion of having two pipes of the same note fastened together, so as I can play on one, and then echo it on the other, which is mighty pretty." — PEPYS's *Diary*, 1668.

"I took my flageolette, and played upon the leads in the garden, where Sir W. Pen come out in his shirt into his leads, and there we staid talking and singing and drinking greater draughts of claret, and eating botargo and bread and butter, till 12 at night, it being moonshine, and so to bed, being very near fuddled." — PEPYS's *Diary*, 1661. (Botargo is a sausage made of eggs and the blood of the sea-mullet.)

Flag′ging-i′ron. (*Coopering.*) A prying-rod with a double-hooked head, used in flagging casks.

Flag′on. A pitcher with a narrow mouth to hold a beverage, ale or wine.

Notably it is of metal, and used to contain the wine of the communion-service, which is poured from thence into the chalice and drunk therefrom.

Flag-stone. A sandstone which cleaves into flat slabs suitable for paving.

Flail. 1. (*Husbandry.*) A wooden instrument for threshing small grain by hand.

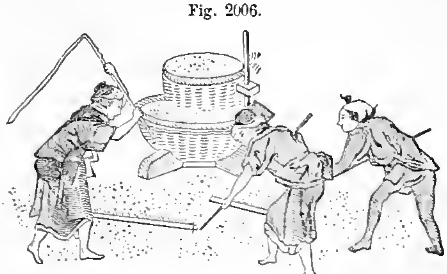
"The fitches are beaten with a staff, and the cummin with a rod." — *Isaiah.*

It was used among the Hebrews for grain which would not bear the tramping or the grinding action of the sled or cart.

The flail consists of the *hand-staff* and the *souple*, or *swiple*, which are joined by a piece of whang or eelskin to a swivel called the *hooding*.

The images of the Egyptian Osiris are represented with two instruments, usually called the *crook* and *flagellum*. We are much disposed, however, to consider them a *sickle* and *flail*, and the association on the same figure of the plow and harrow renders the

Fig. 2006.



Japanese Thrashers.

supposition probable. The crook was not held in as much honor as the sickle, nor the tender of animals as the cultivator of the land. A weapon like a flail was used in war, but Osiris was eminently peaceful and useful, and his emblems had the same character.

The flail is the ordinary means of thrashing in Japan. It differs in no essential respect from that of other countries. The illustration, from a native painting, shows that both sexes engage in the work.

2. An ancient weapon used in war. It was a club swinging from the end of a long handle, like the *morning-stars* of the London train-bands, three centuries since.

A war-club studded with *iron* spikes and mounted like a flail was found at Sakkarah, and is in the Abbott Museum of Egyptian Antiquities in New York.

Flake. 1. A platform of slats, wands, or hurdles, on which fish or fruit is placed to dry. A *fish-flake.*

2. A stage suspended over the side of a ship for the convenience of the painters or calkers.

Flame-bridge. A wall rising from the floor of a furnace to cause the flame to impinge upon the bottom of the boiler.

Flame-en'gine. An early name for the gas-engine, in which the piston is moved by the expansion due to the sudden combustion of a body of gas in the cylinder. See GAS-ENGINE.

Flang. A two-pointed miner's pick.

Flange. (*Machinery.*) A projecting rib or rim for strength, as a guide, or for attachment to another object.

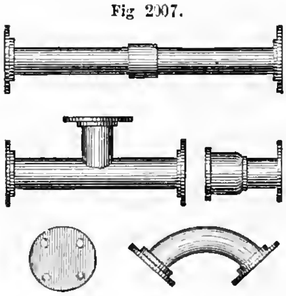
1. A strengthening rib, as in the flange of a fish-bellied rail, or girder.

2. A guide-flange, as in the rib of a car-wheel projecting beyond the tread.

3. A fastening flange, as on the end of pipe, steam-cylinder, etc.

Flange-joint. A joint — such as that of pipes — where the connecting pieces have perforated flanges by which the parts are bolted together.

Fig 2007.



Flanged Sections.

Flange-rail. A rail having a bent-up flange to keep the wheel on the track.

Flang'ing-machine'. (*Sheet-metal.*) A machine usually having two rollers so constructed and arranged as to bend over the edge of a piece of tin-plate which is passed between them. The modes of bending are known as *bending, burring, seaming, flanging,* etc.

In the example, the outer circumferential corner of the lower disk is turned out rectangularly, and the other disk has a peripheral flange, which enters the groove and forms an out-turned flange around the edge of the cylinder. See DOUBLE-SEAMING MACHINE.

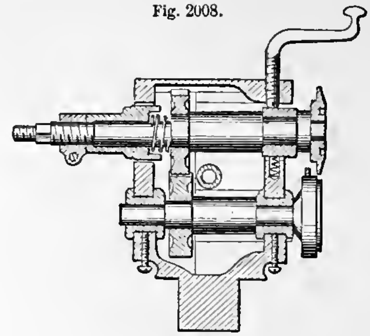
Flank. 1. (*Gearing.*) The acting surface of a cog, *within* the pitch-line. The outer portion is the *face.*

2. (*Architecture.*) The *haunch* of an arch; the shoulder between the *crown* and the *springing.*

3. The thin portion of a skin of leather; that which previously covered the flank of the animal.

4. (*Fortification.*) That portion of a bastion

Fig. 2008.



Flanging-Machine.

which reaches from the *face* to the *curtain.* The *flank* of one *bastion* commands the *ditch* before the *curtain* and the *face* of the opposite *bastion.* See BASTION.

5. The return side of any body, as of a house, a wall, an ashlar in position, etc.

Flan'nel. (*Fabric.*) A soft, open woolen stuff, of which there are many kinds, twilled or plain and undressed, milled, gauze, colored, and checked. Also made for specific purposes, as house, horse, printer's blankets.

Flan'ning. (*Building.*) The internal flare of a window jamb. The *embrasure.*

Or of a fireplace. *Coving.*

Flap. A hinged leaf of a table or shutter.

An inside shutter has several pieces, the principal one of which is the *front shutter;* the one which folds into and is concealed in the *boxing* is the *back-flap.*

Flap-tile. A tile with a bent-up portion to turn a corner or catch a drip.

Flap-valve. A valve which opens and shuts upon one hinged side. A *clack-valve.*

The common pump-valve consists of a disk of leather opening upward when the pump-rod descends, and has a leaden or brass weight attached to it.

Flar'ing. Overhanging, as of the bows of a ship, the top side forward.

Increasing in diameter upward, as of an upwardly expanding pan. *Funnel-shaped, conical, trumpet-mouthed.*

Flash'er. (*Steam.*) A form of steam-boiler in which small bodies of water are injected into a heated boiler and flashed into steam, sufficient being injected at each time for one stroke. See INSTANTANEOUS-GENERATOR.

Flash'ing. 1. (*Hydraulic Engineering.*) Concentrating a fall of water at one point, so as to increase the depth to allow the passage of a boat from one level to another, as at *a.* The river having a *dam* across it and a sluice at one point, the sluice-gate is opened, and during the temporary increase of depth in the sluice-way the boat is drawn through.

It is a very ancient device (see SLUICE), and is still used in many countries with boats of moderate size.

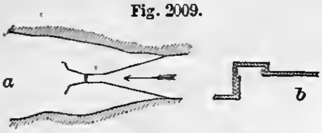
A memorable case of flashing is that when Lieutenant-Colonel Bailey rescued the fleet of gunboats on Red River after the defeat of the Union army under General Banks. The gunboats were *flashed* over the falls at Alexandria by means of a wing-dam made of log cribs filled in with stone.

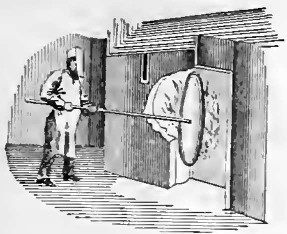
2. (*Plumbing.*) *a.* A lap-joint (*b*) used in sheet-metal roofing, where the edges of the sheets meet on a projecting ridge.

b. A strip of lead leading the drip of a wall into a gutter.

Step-flashings are those situated at the junction of the sloping side of a roof and a wall. They are turned in at each course of bricks and stepped down as the roof descends.

Fig. 2009.





Flashing.

3. (*Glass-making.*) *a*. A reheating at a furnace aperture (*c*) in connection with a rotary movement, causing the opening in the flatted sphere of glass to enlarge and eventually to disappear entirely as the table of glass assumes a flat shape.

The flashing heat is also applied to smooth the sheared edges of a goblet or other article, or to reheat an article during manufacture to restore its plastic condition.

b. A mode of covering transparent white glass with a film of colored glass, in order to give the appearance of color to the whole ware. In some cases, the ruby coating is ground away in an ornamental pattern, so that the glass is party-colored. The colored glass is prepared with a composition called SCHMELZE (which see).

Flash'ing-fur'nace. One at which a globe of crown-glass is reheated, to allow it to spring open flatly as it is whirled. See FLASHING.

Flash'ing-light. One character of light as exhibited from lighthouses. It is produced by the revolution of a frame with eight sides, having reflectors arranged with their faces in one vertical plane and their axes on a line inclined to the perpendicular. The rate of revolution is such as to show a flash of light every five seconds, alternating with periods of dimness.

This light is one of the modes of varying the appearance, so that a mariner may be able to distinguish one light from another when coming near land on a coast where the number of lights is considerable; as, for instance, the three kinds on Cape Henry and Cape Charles, at the mouth of Chesapeake Bay, and at Hog Island, on the coast of Northampton County, Virginia, about thirty miles north of Cape Charles.

Lights are distinguished as —

Fixed.	Flashing.
Revolving.	Colored.
Intermittent.	Double.

These are variously combined, as: *revolving white; revolving red and white; revolving red and two whites; double fixed; double revolving*, etc., etc. See LIGHT; LIGHTHOUSE. See "Lighthouses, their Construction and Illumination," by Allan Stevenson; Weale's Series, No. 47.

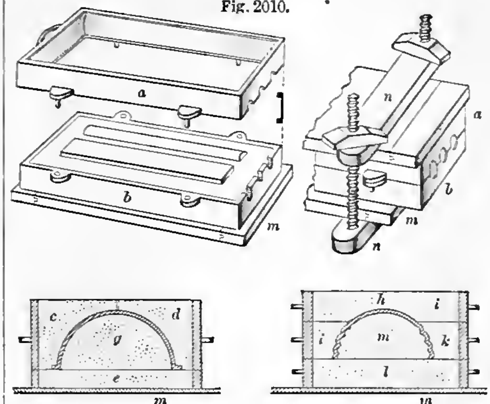
Flash-pipe. A mode of lighting gas by means of a supplementary pipe pierced with numerous small holes throughout its length. The *flash*-pipe reaches from the burner to a position within reach of a person, and is provided with a stop-cock. The cock being turned, gas issues from each orifice. One jet being lit, the flame flashes along the whole length of the pipe, and communicates flame to the jet. The stop-cock is then closed, and the row of small jets is extinguished. Substitutes for the *flash-pipe* are found in the various modes of *lighting gas by electricity* (which see).

Flash-wheel. A water-raising wheel having arms radial or nearly so to its axle, and revolving in a *chase* or curved water-way by which the water passes from the lower to the higher level as the wheel rotates. See SCOOP-WHEEL. See also HYDRAULIC DEVICES.

Flask. 1. (*Founding.*) A frame or box which holds a portion of the mold for casting. If the mold be contained in two pieces, they constitute a *two-part* flask. The upper part contains the *cope* (*a*), the lower part the *drag* (*b*).

In hollow-ware, kettles, etc., the cope consists of two parts *c d*, which divide laterally, and the drag *e*

Fig. 2010.



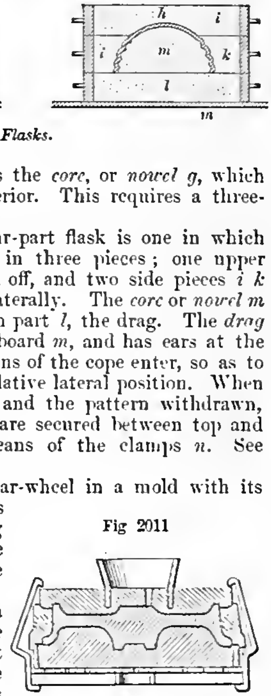
Flasks.

has one part and holds the *core*, or *nowel g*, which is the mold of the interior. This requires a three-part flask.

An example of a four-part flask is one in which the *cope* or casing is in three pieces; one upper piece *h* which is lifted off, and two side pieces *i k* which are removable laterally. The *core* or *nowel m* resting upon the fourth part *l*, the drag. The *drag l* rests upon a bottom board *m*, and has ears at the sides into which the pins of the cope enter, so as to preserve the parts in relative lateral position. When the object is molded and the pattern withdrawn, the *parts* of the flask are secured between top and bottom boards by means of the clamps *n*. See MOLD.

Fig. 2011 shows a car-wheel in a mold with its upper and lower parts and a circular ring which forms and at the same time chills the tread.

Fig 2011



Car-Wheel Mold.

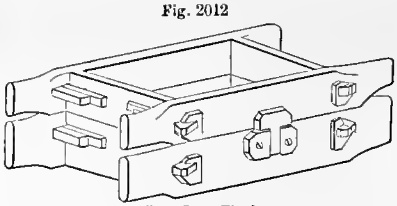
Fig. 2012 shows a two-part flask with the mode of securing exact correspondence of the parts by locking hooks and keepers.

2. A leathern or metallic case for holding gunpowder or shot.

3. (*Glass.*) *a*. A kind of bottle for oil, liquor, or quicksilver. The latter is of iron.

b. A vessel used in a laboratory for sublimation or for digesting in a sand-bath.

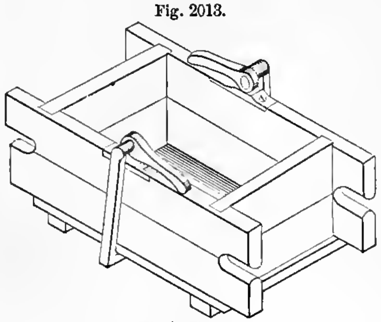
Fig. 2012



Two-Part Flask.

Flask-clamp. A binding device for securely holding together the parts of a flask. In the example it is a hooked bar and a lever cam.

Fig. 2013.



Flask-Clamp.

Flask'et. A long shallow basket with two handles.

Flat. 1. A Western river-boat or barge for carrying produce, coal, or merchandise.

2. A piece of bone for a button-blank.

3. A surface of size over gilding.

4. A story in a dwelling.

5. A platform railway car.

6. (*Carding.*) A strip of wood clothed with bent teeth, and placed above the large cylinder of a carding-machine.

The clothing is known as the *flat top-cards*, in contradistinction to the cards which clothe the *drum*, *licker-in*, *card-rollers*, *teazer*, and *doffer*, whose surfaces are curved.

7. (*Shipbuilding.*) *a.* A flat part in a curve; as a timber which has no curve, as the floor-timbers of the *dead-flat* amidships.

b. One of a number of ship's frames of equal size, and forming a straight middle body.

Flat'band. A plain, square impost.

Flat-boat. A barge for transporting produce on the Western rivers. A *flat*; an *ark*.

Flat-cap. A size of writing-paper usually 14 × 17 inches.

Flat Chis'el. A sculptor's chisel for smoothing surfaces.

Flat File. A file wider than its thickness and of rectangular section. When bellied, it is known as a *taper* file; when the size is maintained from end to end, it is known as a *parallel* file.

Flat Ham'mer. The hammer first used by the gold-beater in swaging out a pile of *quartiers*, or pieces of gold ribbon, 1 × 1½ inches square. These are placed 24 in a pile and beaten till they are two inches square. They are then packaged with interleaves of vellum and beaten by other hammers, known as the *commencing*, *spreading*, and *finishing* hammers.

Flat-head Nail. A forged nail with a round, flat head and a light, rounded, pointed body.

Flat-i'ron. An iron with a flat face, used for smoothing clothes. A *sad*-iron. See SMOOTHING-IRON.

Flat-i'ron Heat'er. A stove specially adapted for heating smoothing-irons. A *laundry-stove.*

Flat-lead. Sheet-lead.

Flat-nail. A small, sharp-pointed wrought nail, with a flat, thin head, larger than a *tack.**

Flat-pa'per. That which has not been folded.

Flat-press. A press used in the india-rubber business for flattening together a number of piles of folded cloth while they are vulcanized and blended together by a steam heat of say 280° F.

Flat-rail. A railroad rail consisting of a simple flat bar, spiked to a longitudinal sleeper. Tramways of wood were laid down by Beaumont at Newcastle, in 1602. They were protected by flat straps of iron in 1738, at Whitehaven. Flat cast-iron plates were laid at Coalbrookdale in 1767. The angular cast-iron rail was used in 1776. Edge rails of cast-iron in 1789. Rolled rails in 1820. See RAIL.

Flat-rope. A rope made by plaiting yarns together instead of twisting. *Gasket; sennit.*

Some flat ropes, for mining-shafts, are made by sewing together a number of ropes, making a wide, flat band.

Flat-rope Pul'ley. A pulley having a true cylindrical surface and two rising flanges, to keep the band from running off. See PULLEY.

Flat'ten-ing-fur'nace. A furnace into which cylinder glass split longitudinally is placed to flatten out by heat. A *spreading-oven.* See FLATTING-FURNACE.

Flat'ter. 1. A hammer with a very broad face, used by smiths in flat-facing work.

2. (*Wire-drawing.*) A draw-plate with a flat orifice, to draw flat strips, such as watch-springs, skirt-wire, etc.

Flat'ting. 1. (*Painting.*) *a.* A style of inside house-painting in which the colors, prepared with oil of turpentine only, are dead, without luster.

b. A covering of size over gilding.

2. A rolling of metal into plates.

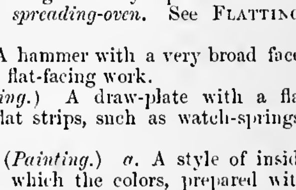
3. (*Glass-making.*) The operation of opening out a split cylinder of glass so as to make it flat. This is performed in a FLATTING-FURNACE (which see), and is assisted by a tool having an iron handle and a wooden cross-piece at the end.

The plate on which it is flatted is of devitrified glass, fire-proof clay, sandstone, or other material which will resist heat and maintain the essential perfectly smooth surface.

It is known as the *spreading-plate*, *flatting-plate*, *flatting-stone*, or *flatting-hearth.*

Flat'ting-fur'nace. One in which a split cylinder of glass is opened out. See FLATTING.

Fig 2014.



Flatting-Furnace.

William Coffan, of Hammonton, New Jersey, patented a machine for flattening cylinder glass, October 1, 1830, which was intended to prevent injury to the glass while cooling by shifting the stone on which it was flattened from the flattening to the cooling oven.

Flat'ting-mill. 1. A rolling-mill producing sheet-metal.

In the Mint; the rolling-mill for producing the ribbon from which the planchets are punched.

The first flatting-mill in England was erected at Sheen, near Richmond, by a Dutchman, 1663.

2. A mill having a pair of hard, polished steel rolls, through which grains of metal are passed to be flatted, for ornamental purposes. The produce is known as *metallic dust.*

Flat-tool. A turning-chisel which cuts on both sides and on the end, which is square. It is used as a bottoming-tool for boxes.

Flaw. 1. (*Weaving.*) A *bore, tangle,* or *skip.*

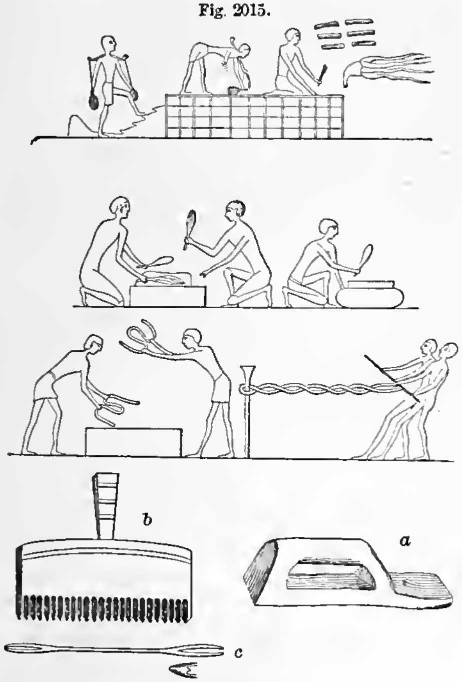
2. (*Metal.*) In casting or forging; a fault, as where the parts of the metal are not fairly joined.

Flaw-piece. (*Wood.*) A slab, from the outside of the log.

Flax. The first mention of flax in history is perhaps that in the account of the hail-storm in Lower Egypt, Exodus ix. 31: "The flax was bolled." The Hebrew word is rendered *linon* in the Septuagint; *linum* in the Vulgate: with us it is *line* and *linen.* (See LINEN.) Flax was used to the exclusion of wool for priestly garments and cerements. Isaiah refers to the fine linen of Egypt; Herodotus refers to linen shirts as the ordinary dress of the people of the Nile land.

The manipulations of flax to render it fit for use are shown at Beni Hassan in Egypt, about 1500

Fig. 2015.



Flax Rotting, Braking, etc. (*Beni Hassan*).

B. C. In the illustration the men on the left are carrying water in jars to pour on the flax, which is placed in an elevated cistern, partitioned off into cells. Another man removes the rotted flax and lays it out to dry, as represented by the six bunches. Another bunch is shown in a loose condition, probably a handful in condition for the next operation, which is performed by the three kneeling men, who beat upon a stone with a mallet *a.* The flax is thus made into a rough hank, and is then cleaned and opened out more fully by striking it upon a stone. The hank is held in two places, swung in the air, and beaten upon the flat stone. In the next scene the hank is twisted and worked to give it a farther finish.

The description given of the process by Pliny, who wrote about 1500 years afterwards, will nearly apply to the serial picture just described. He says: "The stalks themselves are immersed in water, warmed by the heat of the sun, and are kept down by weights placed upon them; for nothing is lighter than flax. The membrane or rind becoming loose is a sign of their being sufficiently macerated. They are then taken out and repeatedly turned over in the sun until perfectly dried; and afterwards beaten by mallets on stone slabs. That which is nearest to the rind is called *stupa* (tow), inferior to the inner fibers and fit only for the wicks of lamps. It is combed out with iron hooks until all the rind is removed. When made into yarn it is polished by striking it frequently on a hard stone, moistened with water; and when woven into cloth it is again beaten with clubs, being always improved in proportion as it is beaten."

Answering to the "iron hooks" described by Pliny, and to our *hackle,* were the combs like that shown in the cut *b*; two of which were found at Thebes, with some flax-tow attached, and are now in the Berlin Museum. One of them has 29 and the other one 46 teeth. *c* is a netting-needle from the same place.

Flax was exported from Egypt to Gaul as late as the Christian era, and was ordered to be grown in England by statute of Henry VIII., 1533. A braking and scutching machine was run by water-power in Scotland in 1750.

To prepare flax for manufacture, after the removal of the seeds, the *harl* (useful, fibrous portion) is separated from the *boon* (the refuse portions of the stalk). For this purpose the uniting gluten must be dissolved and removed. This is effected by rotting, either in ponds or by exposure to dew. In either case a fermentation ensues which renders the gluten soluble in water. Caustic alkali has the same effect on gluten, and forms the basis of many modern processes whereby woody fiber is rendered suitable for spinning or for paper pulp. The next process is to *break* and *scutch* the flax to detach and remove the rind and cellulose matter, and prepare the fiber for *hackling* and subsequent operations.

In one large establishment in Leeds, England, the series of machines is as follows: —

The seed is removed by rollers which act upon the bolls. Then come the *flax-braking machines;* these have fluted or grooved rollers, between which the flax stem is made to pass, so that the woody portion becomes thoroughly broken without cutting the fiber. Next come the *flax-scutching* machines, in which revolving blades or arms beat out the woody fragments, and the fibers are to a certain degree separated. After this the *flax-hackling* machines give the flax a thorough combing, by means of long rows of teeth or spikes; the fibers are combed out straight and tolerably clean; and the tow or short fibers are removed, to be used for other purposes. The hackled flax is then in a state to be acted on by the various machines which bring it into the state of yarn for weaving; these machines are of three kinds, according as tow, long flax, or cut flax is to be acted upon. The *tow-carding* and the *tow-roving* machines serve for the first kind; the *flax-spreading, flax-carding,* and *flax-roving* machines for the second; and the flax-cutting machine, followed by those for carding and roving, for the third. The spinning-machine follows all these; and it differs from cotton-spinning machines chiefly in having a provision for wetting the flax either with cold or hot water; there is still a little gum or mucilage among the fibers, and this becomes more manageable in the machine when moistened.

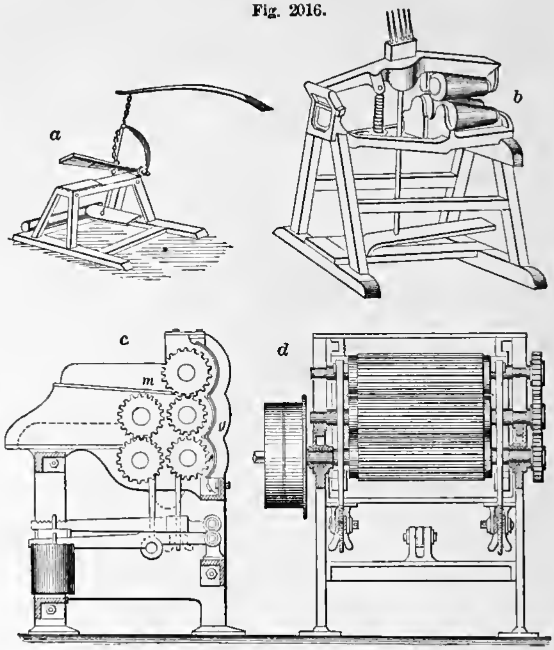
A Swedish method of treating flax is by boiling in sea-water with the addition of birch-ashes and quicklime. It is then rinsed in sea-water; soaped, rubbed, bleached in the air, being turned and watered every day. The washing, soaping, and bleaching are repeated. The flax is beaten, dried, and then carded and spun like cotton.

For list of appliances in the treatment and manufacture of flax, see COTTON, FLAX, WOOL, ETC., APPLIANCES.

Flax-brake. 1. A machine for removing the woody and cellular portion of flax from the fibrous. The hemp-brake is substantially similar in its construction and identical in its purpose.

The first mode adopted may be assumed to have been beating the rotted flax with a stick on a flat stone, alternating with rubbing by the hands. A sword of wood which descends upon the stalks laid over a pair of slats set edgeways, a farther improvement, which is shown at *a*, in which the sword is drawn down by a treadle and lifted by a spring-pole. To this succeeds a pivoted jaw with a series of parallel longitudinal serrations descending upon a similarly provided jaw on the bench.

Fig. 2016.



Flax-Brakes.

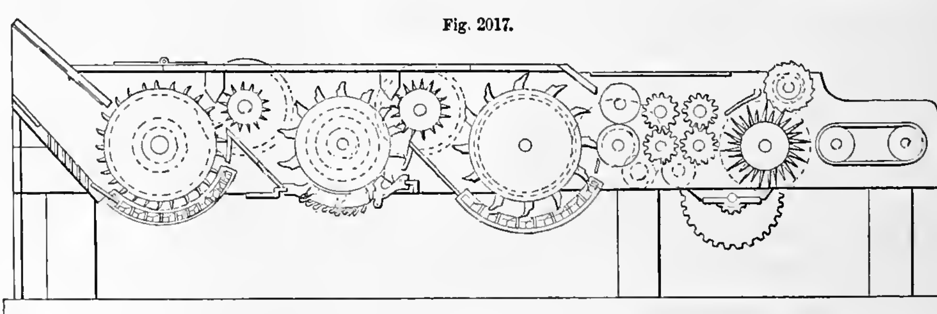
b is a machine having a system of three rollers, the upper one of which is attached to a lever which draws it down upon the other two by means of a treadle, clamping the flax, which is then drawn through by hand, breaking the *shives* from the *hare*. This is repeated as often as may be neccessary, raising the head each time for the insertion of the flax. This part of the process being completed, the flax is reduced to a fine straight fiber by means of the hackle above the lever.

The machine shown in side and end elevations *c d* has cast-iron fluted rollers, five in number, arranged in two vertical series, the front one of two rollers and the back one of three.

The flax straw fed into the machine at *m* passes between the top and middle rollers of the back series, and is directed downward by the back plate *g*, so as to pass between the middle and bottom rollers of the same series and then through the two rollers of the front series. The rollers are all driven and their ends have plain parts truly turned so that the flutes of one roller work into the spaces of the next adjoining roller, and leave a space for the flax straw to pass through. The rollers are weighted, and the pressure can be regulated as required.

Fig. 2017 shows a machine for consecutive rotary

Fig. 2017.



Flax Brake and Cleaner.

treatment. The devices are for drawing, straightening, and extending a layer of tangled flax so as to reduce it to a thin, even sheet of parallel stalks ready for the breaker, scutcher, beater, and picker, to which it is passed directly and continuously.

The drawing-cylinder has alternately long and short teeth, and the roller above has indentations in the peripheries of its annular rings for impaling the stalks. The scutching and cleaning cylinders have flat, narrow, deep teeth, with inclined front edges, slightly hooked at the ends. The teeth of the picking-cylinder are made of pointed round wire, and are inclined backward at their bases, their points curving forward. The concave of the cleaning-cylinder is formed of parallel curved grate-bars, between which pass the teeth of the cylinder. The fiber is forwarded between each cylinder by chute and toothed shell roller.

2. A machine for shortening flax staple to adapt it to be worked by a given class of machines.

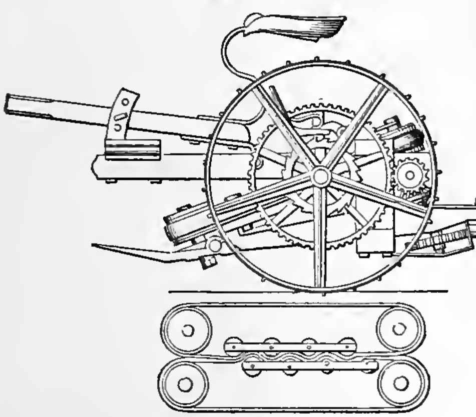
Flax-cot'ton. A process was invented by Chevalier Claussen for cottonizing flax, to render it suitable for manufacture, the objects being to expedite the processes of separating the fiber from the cellular and glutinous matters, and then reducing the fiber to a staple which can be readily treated by machinery. The flax-straw is boiled for four hours in a solution of caustic alkali in a stone vessel, by which the extraneous matters are loosened; it is then placed for two hours in a bath slightly acidulated with sulphuric acid. It is then dried and scutched to remove the cellulose. The cottonizing is performed by steeping the fiber in a bath of dilute bicarbonate of soda, and subsequently in an acidulated liquid. The action of the acid and alkali within the flax fiber generates carbonic-acid gas, and has the effect of bursting apart the fibers, which assume a cottony appearance. It is then bleached and spun, either mixed or otherwise.

In the first volume of the "Transactions of the Society of Arts" is a paper detailing the experience of Lady Moira, about 1770, in attempting to introduce flax cotton. She states that tow and refuse flax of all kinds, boiled with an alkaline solution, and afterwards soured, is converted into a sort of cotton which takes dye better than flax. Her comments are really noteworthy, and illustrate the oft-told tale of the difficulties which inventors and discoverers have to struggle against in the preconceived opinions of others.

Flax-cut'ting Ma-chine'. Flax is sometimes cut before hackling in order to enable its separation according to quality. The machine for this purpose has a circular saw which partly cuts and partly tears its way through the bunch of flax which is presented to it by pairs of parallel rollers on each side of the saw.

Flax-pull'er. A machine for pulling flax-plants

Fig. 2018.



Flax-Puller.

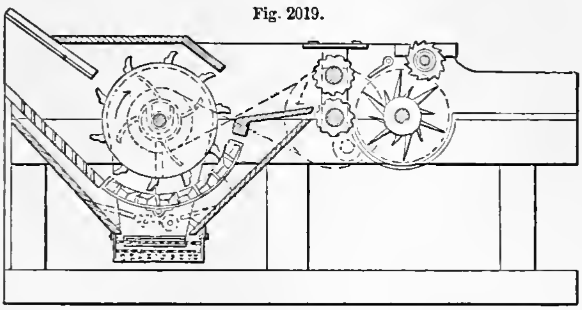
in the field. In the example, the flax passes between a series of dividing fingers, and is seized by the endless rubber belts which are so inclined from the horizontal as to draw the flax from the ground and deposit it on the platform.

Flax-scutcher. See SCUTCHER.

Flax-seed Mill. One for grinding flax-seed for the more ready abstraction of the oil, generally known as linseed (*lint*, flax) oil. It is usually a coarse grist-mill, but is sometimes of a portable form and size for farm or plantation use, and adapted for other grain and seeds. See GRINDING-MILL.

Flax-thrasher. One for beating the grain from the bolls of the cured flax-plant. In the example, the tangled flax is impaled by the spiked roller against the indented roller above, while the drawing rollers straighten the stalk and feed it to the thrashing

Fig. 2019.



Flax-Thrasher.

cylinder, which removes the bolls: the latter then fall between the crushing rollers, which release the seed to be cleaned by the vibrating winnower beneath.

The difficulty in thrashing flax consists in its tendency to wrap around the shafts and thrashing cylinder.

Fleam. A spring lancet for bleeding horses.

A gum-lancet. The fleam (phlebotom) was used by the Greeks.

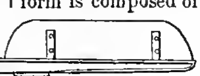
Fleam-tooth. Of a saw. One in the form of an isosceles triangle. A *peg-tooth.*

Fleche. (*Fortification.*) An advanced work at the foot of the glacis, consisting of a parapet with faces forming a salient angle, open at the gorge. It has a communication with the covered way cut through the glacis.

Fleece. 1. The fine web of carded fibers which are removed by the comb or doffing-knife from the doffing-cylinder of a carding-machine.

2. The wool of a sheep in an unbroken mat.

Fleece-fold'er. A kind of press used in condensing the folded fleece so that it may be tied by twine into a compact bundle for shipment. The platform is composed of leaves hinged to a central piece.



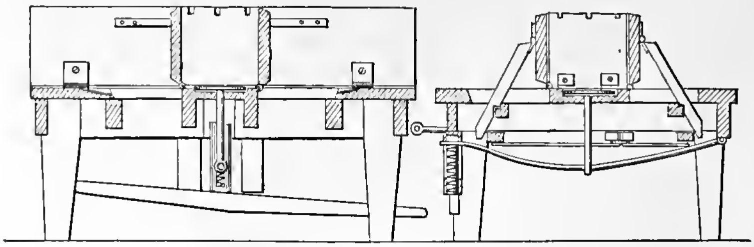
The wool is laid on the leaves, which are then raised and held in position by notched bars until the package is bound, when they are lowered. A plate, connecting with a spring-balance scale, is placed in the central piece and raised by a lever until the package of wool rests upon it. See WOOL-PACKER.

Fleet. (*Nautical.*) *a.* To draw apart the blocks of a tackle.

b. To allow the cable or hawser to slip on the whelps of the capstan or windlass, from the larger to a part of smaller diameter.

Flem'ish-eye. (*Nautical.*) An eye made at the end of a rope, without splicing. The ends of the strands are tapered, passed over oppositely, marled, and sewed with spun-yarn. A *made-eye,* in contradistinction to a *spliced-eye.*

Fig. 2020.



Fleece-Folder.

Flem'ish-horse. (*Nautical.*) A foot-rope for the man at the earing in reefing. The *horse* extends below the yard; the *Flemish horse* is the outer portion.

Flesh-brush. A soft brush to be used on the skin to promote circulation and excite the surface secretions.

Flesh-hook. A hook to hang meat.

A hook to handle meat in a pot or caldron.

Flesh'ing. (*Leather-manufacture.*) The operation of removing fat, flesh, and loose membrane from the flesh side of skins and hides. The operation follows that of *unhairing*, and is performed on a beam by a convex knife with a sharp edge.

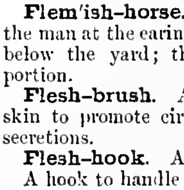
Flesh'ing-knife. A convex knife with a sharp edge used in removing the flesh and fat from the inner surface or *flesh-side* of the hide.

Flews. A sluice for letting waters off irrigated meadows (Scotch).

Flex'i-ble-bind'ing. (*Bookbinding.*) A book sewn on bands raised above the back of the folded sheets, so as to allow them to open more freely. The sewing-thread passes around the bands.

Flex'i-ble-coup'ling. Thirion's flexible coupling is used for conveying power from one shaft to another when they are not in line. It is a spiral steel band attached at its opposite ends to the two shafts to be connected. The diameter of the spiral is larger than that of the shaft, and the attachment is shown as consisting of a cast-iron cap. For a joint of transmission amounting to a right angle, fifteen coils of a spiral will be sufficient. Another form is a cylindrical plug or rod of india-rubber connecting the shafts. See also Universal Joint.

Fig. 2021.



Thirion's Flexible Coupling.

Fli'er. See Flyer.

Flight. 1. (*Carpentry.*) A series of parallel steps proceeding in one direction without turning.

In *dog-legged* stairs, the lower is the *leading* flight, the upper the *returning* flight.

2. The slope or inclination of the arm of a crane or of a cat-head.

3. A spiral wing or vane on a shaft, acting as a propeller or conveyor.

Flight'er. A horizontal vane revolving over the surface of wort in a cooler, to produce a circular current in the liquor.

Flint. A variety of silicious stone used to strike fire; also largely used in making the fine kinds of pottery. Its uses — domestic and for fire-arms — for striking fire are now much abridged among civilized nations. The friction-match and fulminating-powder have superseded the flint and steel.

Flint-glass. This description of glass is made into tumblers and other drinking-vessels, fine table ware and bottles, and various articles of decorative furniture and fittings. It is made of white sand, 52; carbonate of potash, 14; and oxide of lead, 33; alumina, 1; with metallic additions to neutralize color. The articles are made by the agency of the blow-pipe, or ponty, the mold and press, and frequently by a combination of blowing and pressing. The silica for its manufacture was formerly derived from pulverized *flints*, and hence its name. The presence of lead gives it a peculiar property of refracting light, which causes it to be used for lenses, and it forms one of the parts in achromatic compound lenses.

It fuses at a lower temperature than ordinary glass, such as the *crown*, *plate*, or *window* glass. It has also less color, owing to the use of the alkali potash, instead of soda, the latter imparting a greenish tinge to glass.

Flint-glass is softer than some other varieties, and is the kind which is *cut*.

Artificial gems consist of flint-glass, colored in imitation of the natural tints of the gems. See Strass.

Pure white sand free from oxide of iron is required for flint-glass, as iron imparts a green color.

The Bohemian glass is a silicate of potash and lime, a little of the silicate of alumina being substituted for the oxide of lead. The silica for this glass is obtained by pounding pure white quartz.

Flint-glass work is classed as —

1. Blown.
2. Molded and pressed.
3. Cut and engraved.
4. Reticulated and spun with a variety of colors, incrusted, flashed, enameled of all colors, opalescent, imitation of alabaster, platinized, silvered, etc.
5. Glass mosaic, Millefiori, Aventurine, and Venetian glass weights, etc.
6. Beads, imitation pearls, etc.
7. Glass accessories to lamps, gas-lights, brackets, etc., such as globes, chimneys, drops, bells, reflectors, etc.

Flint-knife. A knife of archæological interest, made from flint chipped to shape.

Flint was very early used as a cutting implement by the nations so fortunate as to possess it. A sort of saw, which passed for a knife, consisted of flakes of flint inserted into wooden handles and secured by bitumen or by lashings of gut or sinews. Obsidian was used in the same way. The South-Sea-Islanders had no flint or obsidian, and used shell, splinters of bamboo, and flakes of tortoise-shell. See Knife.

Flint-lock. The old-fashioned lock for fire-arms, in which the cock held a piece of flint and came glancing down upon the steel cap of the pan which contained the priming.

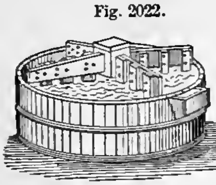
Flint-locks were invented early in the seventeenth century, and gradually superseded the match-lock. Pyrites or marcasite was also used. See Gun-lock.

Flint-mill. 1. (*Pottery.*) A mill in which burned flints, having been previously stamped to reduce them below a certain size, are ground to powder for mixing with clay to form *slip* for porcelain.

The flint-mill is a strong circular pan ten or twelve feet in diameter, having a bottom of quartz or felspar blocks, and a runner or runners of hard silicious stones, called *chert*, lime in any form being inadmissible, as it forms a flux for the other material which would vitrify in the *seggars* or become blistered by the escape of carbonic acid.

The mill is of the nature of an *arrastra*, as the running stones are blocks driven by depending bars from the arms which project radially from the rotating vertical axis.

Fig. 2022.



Flint-Mill.

The fractured flint is fed into the pan, and water to the depth of eight inches is added. The flint is ground by being levigated between the runners and the bed, and by grinding the particles against each other.

The machine resembles the arrastra of Spain and the Spanish countries of America, excepting that in the arrastra the blocks are dragged around in the bed, being connected by thongs to the revolving arms; and also that the argentiferous slimes are treated with mercury in the arrastra, instead of being merely levigated in water. See ARRASTRA.

The flint-pan is the invention of Brindley, so celebrated for his energetic prosecution of the British canals. Before its introduction the flints were ground dry, and the dust proved very fatal to the work-people.

Mills of similar character, on a smaller scale, are used for grinding felspar, broken porcelain, and other ingredients used in the pottery and porcelain manufacture.

2. (*Mining.*) A mode formerly adopted for lighting mines in which flints studded on the surface of a wheel were made to strike against a steel and give a quick succession of sparks to light the miner at his work. Sparks will not inflame the fire-damp.

Flint-wall. A wall common in some parts of England, made of broken flints set in mortar, and with quoins of masonry. The black surfaces of the broken flints are exposed on the face of the wall.

Flint-ware. (*Pottery.*) A superior kind of earthenware into whose composition ground flint largely enters. See PORCELAIN.

Flisk. A large-toothed comb.

Flitch. (*Carpentry.*) *a.* One of several associated planks which are fastened side by side to form a compound beam, or *built-beam.*

b. A bolt of planks, united by the *stub-shot.*

Float. (*Hydraulic Engineering.*) 1. One of the boards or paddles attached to the radial arms of a paddle-wheel or water-wheel.

2. The hollow, metallic ball of a self-acting faucet, which *floats* upon the water in the cistern or boiler. See BALL-COCK.

3. The quill or cork from which the bait line is suspended, and whose motion indicates the bite of a fish.

4. A plasterer's trowel (*a*), used in spreading or *floating* the plaster on to a wall or other surface.

The *long* float is of such a length as to require two men to use it.

The *hand*-float is that in ordinary use.

The *quirk*-float is used in finishing moldings.

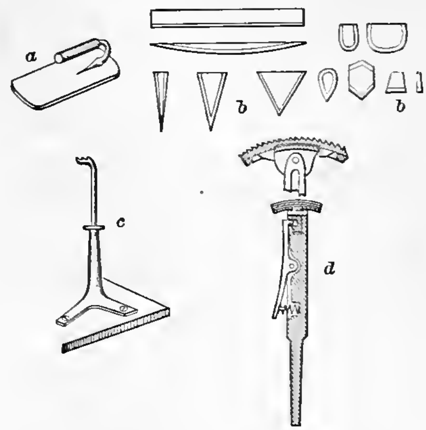
An *angle*-float is shaped to fit the angle formed by the walls of a room.

5. A *single-cut* file, or one in which the teeth are parallel and unbroken by a second row of crossing teeth.

The usual horizontal obliquity of the teeth relatively to the central line of files is 55°, but *single-cut* files are much less inclined, and the teeth of *floats* are sometimes square across the face of the file.

The floats of comb-makers and ivory-carvers are made of various shapes (*b b*), and those of the former

Fig. 2023.



Floats.

are known by specific names, as *graille, found, carlet, topper.* (See COMB.) The teeth have a forward inclination of about 15°, and are made by a file, not a chisel. They are of a lower temper than usual, and are sharpened by a burnisher.

6. The serrated plate (*c d*) used by shoemakers for rasping off the ends of the pegs inside the boot or shoe.

7. (*Tempering.*) A contrivance for affording a copious stream of water to the heated steel surface of an object of large bulk, such as an anvil or die in the process of tempering. The rapid production of steam prevents the constant contact of cold water when the object is merely dipped, as a body of steam intervenes. The dashing stream of water exposes constantly a new body of water to the hot surface, and makes the hardening more complete.

In the English Mint, a powerful jet of water is used in hardening the dies.

8. A coal-cart.

9. A small raft of timber, say 18 feet square and 1 foot deep.

10. A polishing-block used in marble-working. A *runner.*

11. An inflated bag or pillow to sustain a person in the water. A *cork-jacket.* Ormsbee's float is an annular bag placed as a sleeve upon the arm or around the buttocks. It is made of water-proof material, and is inflated when required. See LIFE-PRESERVER.

Float-board. One of the boards of an undershot water-wheel or of a paddle-wheel.

Float-case. (*Hydraulic Engineering.*) A caisson to be attached to a submerged ship or other body, to float it by the expulsion of water and substitution of air in the case.

Float'er. (*Hydraulic Engineering.*) A registering float on a graduated stick to indicate a level attained between periods of observation.

Float'ing. 1. (*Weaving.*) A term applied to a thread which spans a considerable number of threads without intersection. This is an incident to twilling. (See TWILL.) *Diapers*, for instance, are *five-leaf twills;* that is, every warp *floats* under four threads of woof, and is raised and interwoven with the fifth. Also called *flushing*.

2. The second coat of three-coat plastering.

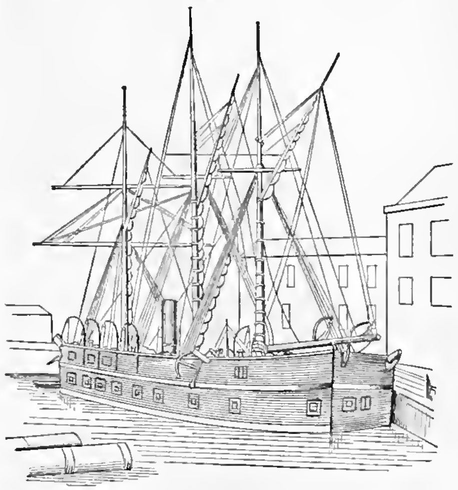
Float'ing-an'chor. (*Nautical.*) A frame of spars and sails dragging overboard, to lessen the drift of a ship to leeward in a gale. A DRAG-ANCHOR (which see).

Float'ing-bat'tery. A vessel strengthened so as to be shot-proof, or as nearly so as possible, and intended for operating in comparatively smooth water, for defending harbors or attacking fortifications.

We are told that a ship of this kind called the "Santa Anna," sheathed with lead, of 1,700 tons burden, carrying 50 guns and having a crew of 300 men, was built at Nice in 1530. She belonged to the Knights of St. John, and was employed by Charles V. against Tunis in 1535.

At the siege of Gibraltar in 1782, by the French and Spanish, ten Spanish war vessels were converted into floating-batteries by strengthening their sides with timber, raw hides, and junk, to a thickness of seven feet; they were also fitted with sloping bomb-proof roofs or decks, and are said to have mounted 212 guns, principally 32-pounders, which were considered heavy guns in those days; they were manned with more than 5,600 men, and provided with furnaces for heating shot and arrangements for extinguishing fires. They were constructed by D'Arcon, a French engineer, and were first employed in the attack of September 13, 1782, and sustained the heaviest fire of the British during nearly the whole of that day without apparent injury, but were at last set on fire by hot shot.

Fig. 2024.



Crimean Floating-Battery.

In 1813, Robert Fulton submitted a plan to the United States government for the construction of a large floating-battery, which was accordingly built; she was 156 feet in length, 56 feet beam, and 20 feet deep, propelled by a single wheel 16 feet in diameter; her sides were very thick, and she is said to have attained a speed of five miles an hour against the tide.

During the Crimean war the French constructed several floating-batteries, which were sent into the Black Sea, and rendered very efficient service at the capture of Kinburn. The English shortly afterwards commenced building vessels of a similar class, but none of these were completed in time to be of service during that campaign.

Those of the French were of wood, and plated with iron four inches in thickness; they were built very flat, but were to a certain extent sea-going vessels.

The English ones, such as the "Erebus," were constructed almost exclusively of iron, and mounted a very heavy battery, consisting of thirty 8-inch guns.

The Stevens floating-battery is a very sharp screw steamer, designed for great speed, and will be found more fully described under the head of ARMOR-PLATING. See also IRON-CLAD; MONITOR; etc.

Float'ing-bridge. 1. A form of ferry-boat which is guided and impelled by chains which are anchored on each side of the river, and pass over wheels on the sides of the vessel, the wheels being driven by steam-power. Lifting platforms at each end admit vehicles.

2. The *floating-bridge* for canals rests on a *caisson* or *ponton*, and is opened and closed by chains and windlasses. When it is open, it lies in a recess in the side of the canal made to receive it. The ponton is made of sheet-iron, and is designed to act as a girder when the bridge is closed.

Bridges across the Hamoaze, Humber, and Itchin, in England, and the bridge which so long crossed the Susquehanna at Havre de Grace, Maryland, are instances of floating-bridges which might almost as well be called ferry-boats; the distinction is not easy to draw, and is not very important. The train ran on to a high deck and was floated across; the differences of level due to tide were met by a hinged trainway.

Float'ing-clough. A barge with scrapers attached, which is driven by the tide or current, to rake up the silt and sand over which it passes, so that the sediment may be removed by the current.

Float'ing-dam. (*Hydraulic Engineering.*) A caisson used as a gate for a dry-dock.

Float'ing-der'rick. One adapted for river and harbor use, in raising sunken vessels, moving stone for harbor improvements, etc. See DERRICK.

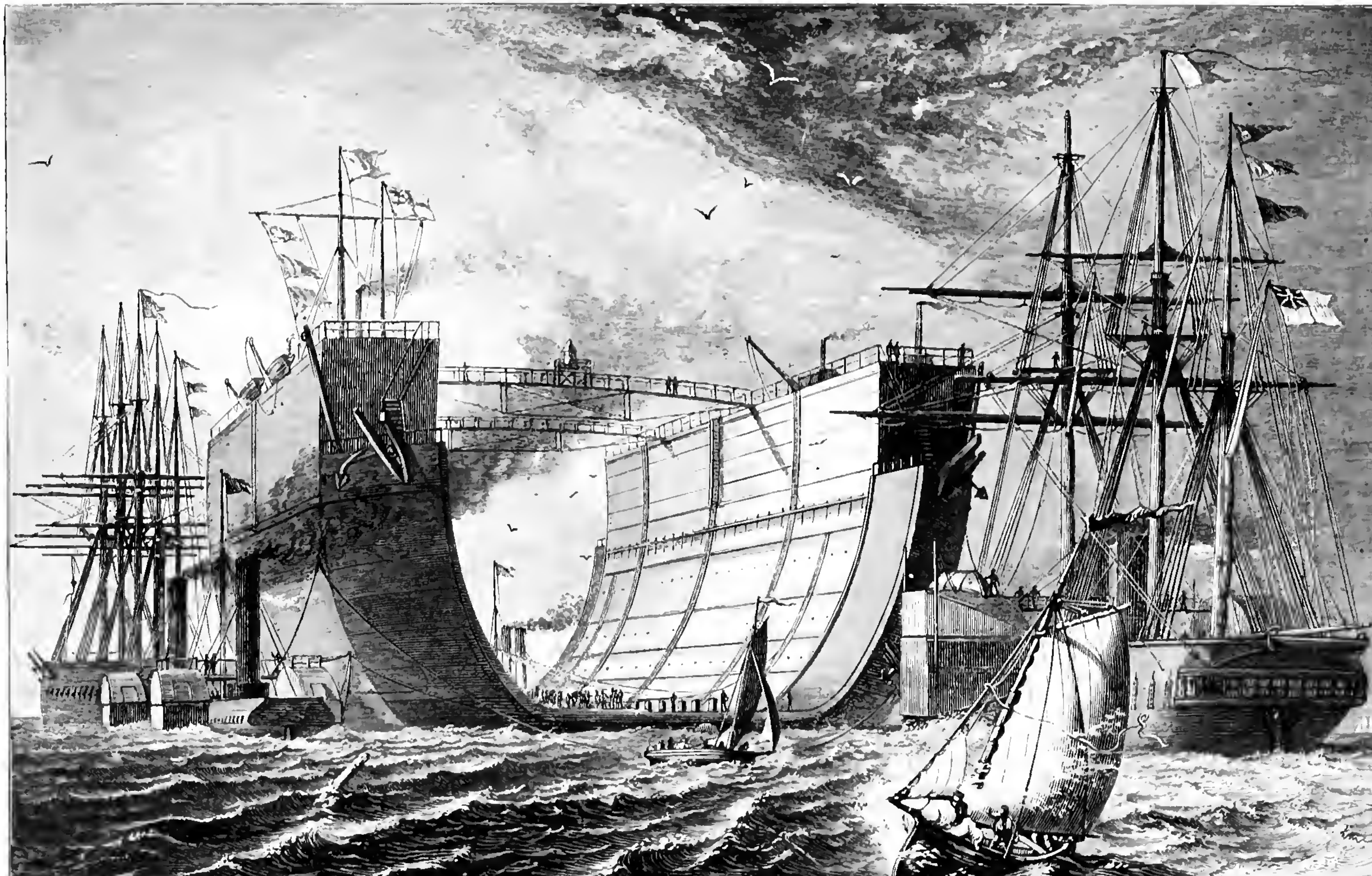
Float'ing-dock. An iron vessel of a rectangular shape, with a rounded bow and a strong caisson gate at the stern. The vessel has a double skin, with a large intervening space. Into the inner basin a ship is floated while the dock is partially submerged; the caisson being closed, the water in the dock and in the space intervening between the two skins is pumped out, so that the interior may be dry, to allow work on the vessel, and the jacket may have sufficient flotative power to carry its load.

The estimated proportions of the inner and outer skin are: the latter should be one third broader and deeper than the former. The intervening space is divided by bulk-heads.

The weight or unloaded displacement is estimated at $\frac{5}{10}$ to $\frac{6}{10}$ of its load displacement, giving from $\frac{5}{10}$ to $\frac{4}{10}$ for its lading.

The largest vessel — for such it is — of this class is the "Bermuda," built in England and navigated to the Bermudas, being towed by two war vessels by way of Madeira, where there was a relay of tugs. This dock cost $1,250,000, and is represented on the opposite page. It has the following dimensions: extreme length, 381 feet; width inside, 83 feet 9 inches; width over all, 123 feet 9 inches; depth, 74 feet 5 inches. The weight of the dock is 8,350 tons.

The dock is U-shaped, and the section throughout is similar. It is built with two skins fore and aft, at a distance of 20 feet apart. The space between



THE ENGLISH FLOATING DOCK "BERM

PLATE [illegible]

See page 884.

the skins is divided by a water-tight bulk-head, running with the middle line the entire length of the dock, each half being divided into three chambers by similar bulk-heads. The three chambers are respectively named "load," "balance," and "air" compartments. The first-named chamber is pumped full in eight hours when a ship is about to be docked, and the dock is thus sunk below the level of the horizontal bulk-heads which divide the other two chambers. Water sufficient to sink the structure low enough to admit a vessel entering is forced into the balance chambers by means of valves in the external skin. The vessel having floated in, the next operation is to place and secure the end caissons, which act as gates, and eject the water from the "load" chamber. Then the dock with the vessel in it rises, the water in the dock being allowed to decrease by opening the sluices in the caissons. The dock is trimmed by letting the water out of the "balance" chamber into the structure itself. The inside of the dock is cleared of water by valves in the skin, and it is left to dry. When it becomes necessary to undock the vessel, the valves in the external skins of the "balance" chamber are opened in order to fill them, and the culverts in the caissons are also opened, and the dock sunk to a given depth. From keel to gunwale nine main water-tight ribs extend, farther dividing the distance between the two skins into eight compartments. Thus there are altogether forty-eight water-tight divisions. Frames made of strong plates and angle-iron strengthen the skins between the main ribs. Four steam-engines and pumps on each side — each pump has two suctions, emptying a division of an "air" chamber — are fitted to the dock, and these also fill a division of the "load" chamber. When it becomes necessary to clean, paint, or repair the bottom of the dock, it is careened by the weight of water in the load chambers of one side, and the middle line is raised about five feet out of the water.

The "Royal Alfred," bearing the flag of the admiral on the station, and weighing 6,000 tons, was lifted by this dock, her keel resting on a central line of blocks arranged on the floor of the dock, the ship being shored up with timbers all round the top-sides.

A similar dock was sent in sections to Carthagena, and lifted several vessels of from 3,800 to 5,600 tons, in one case (the "Numancia") supporting the vessel eighty days.

Float'ing-har'bor. A breakwater of cages or booms, anchored and fastened together, and used as a protection to ships riding at anchor to leeward.

Float'ing-light. 1. A light exhibited at the mast-head of a vessel moored on a spit or shoal where no adequate foundation exists for a permanent structure. The *screw-pile*, in affording a new means of founding structures, has enabled light-houses to supersede floating-lights in numerous cases. A *light-ship*.

2. A life-preserving buoy with a light to attract the man overboard, and to direct the crew of a boat coming to his rescue.

Float'ing-plate. (*Stereotyping.*) A flat cast-iron plate placed at the bottom of a square cast-iron tray in which a stereotype is cast. The plaster mold is laid, face down, on the *floating-plate*, and the two are placed in the heated *dipping-pan*, the cover of which is screwed on. The *dipping-pan* is plunged in an iron pot containing the molten alloy, which runs in at the gates and floats the plate and mold; the latter has notches at its edges, which allow the metal to penetrate between it and the plate. The result is a casting with a flat back, and a face with cameo impression resembling the original type.

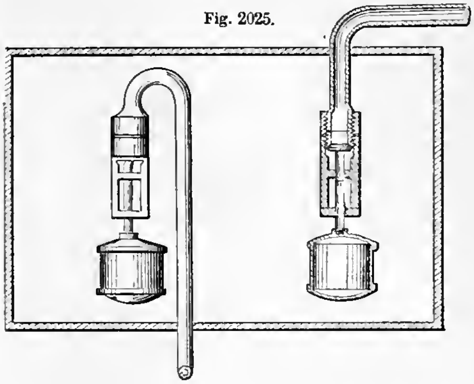
Float'ing-safe. A buoy-shaped receptacle for papers, letters, and valuables, to be cast overboard in case of foundering or wreck.

Float'ing-screed. (*Plastering.*) A strip of plastering first laid on to serve as a guide for the thickness of the coat.

Float-stone. (*Bricklaying.*) A rubber used by bricklayers for smoothing compass-bricks for curved work, such as the cylindrical backs and spherical heads of niches. It takes out the axe-marks acquired in roughly dressing to shape.

Float-valve. A valve actuated by a float so as to open or close the port, according to the level of the liquid in the chamber where the float is placed. It is the equivalent of a *ball-cock*.

Fig. 2025.



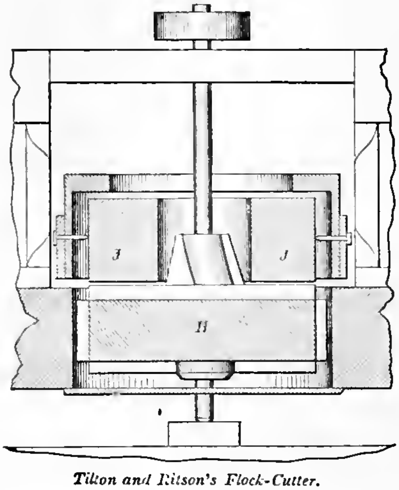
Float-Valve.

Flock. 1. Wool-dust used in coating certain portions of the patterns in wall-papers. The wool is the short refuse of the factory, much of it being derived from the cloth-shearing machine. It is scoured, dyed, dried, and ground, sifted into grades, and dusted over the varnished surface of the paper.

2. A fibrous material for stuffing upholstery, mattresses, etc. It is made by reducing to a degree of fineness, by machinery, coarse woolen cloths, rags, tags, old stockings, etc.

Flock-cut'ter. A machine for cutting fiber to a very short staple, called *flock*.

Fig 2026.



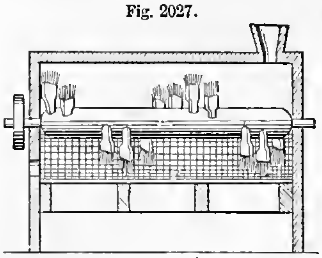
Tilton and Ritson's Flock-Cutter.

In Barber's patent (1846) it consists of a cylinder with spiral knives rotating in contact with a concave having straight knives, the effect being a shear cut upon the fiber passing between the edges, which shave past each other. See also Chase, 1862; Pitts, 1856; Marble, 1872.

The example (Fig. 2026) has a bed in which knives are arranged in parallel groups, of which one in each group is radial and the others of the group parallel therewith. The lower cutter *H* has a rotary motion and a vertical adjustment. The other cutter *J* has a self-adjusting movement, without rotation, but floating, as it were, on the surface of the runner.

Flock-dust'er. For removing dust from flock. The material is agitated by beaters in a gauze cylinder with interior ribs; or it is fed into the hopper at one end of the case and is discharged at the other end, being dusted and loosened by the inclined brushes which impel it forward. The dust escapes through a semi-cylindrical screen.

Fig. 2027.



Waterhouse's Flock-Duster.

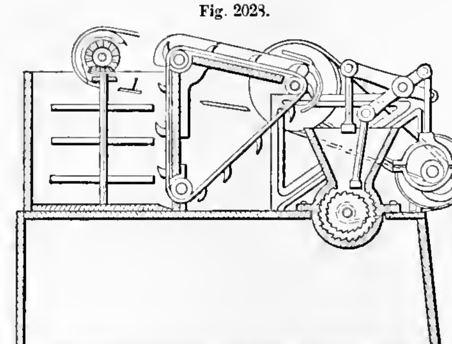
Flock-grind'ing Ma-chine'. A case of the form of a hollow cone, containing a revolving cylinder of the form of the frustum of a solid cone. Both are provided with spirally arranged knives, held between segmental binder-plates. Apertures at both ends are provided, so that the machine may be fed and run in either direction, to sharpen the knives and grind at the same time.

M'Allister's, 1870, has a cylinder of oblique blades operating upon vertical parallel blades on the concave beneath.

In some cases the grinder is a frustum of a cone discharging at the base.

In the example (Fig. 2028), the box has radial agitators on a vertical, rotating shaft. The endless

Fig. 2028.



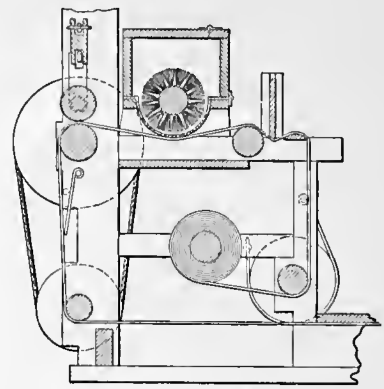
Flock-Grinder.

apron passes up one side, and has cups carrying up the material and conveying it to the hopper of the tearing cylinder. The material is forced down upon the tearing cylinder by reciprocal plungers.

Flock'ing-ma-chine'. One for distributing flock on a prepared surface of cloth or paper.

In the example, the cloth is passed on an endless

Fig. 2029.



Chaffee's Flocking-Machine.

web with its varnished side uppermost, beneath a brush whose upper portion rotates in a box of flock.

Flock-o'pen-er. A machine with pickers or stiff brushes for tearing apart the bunches of flock, so as to make a light, loose fiber which shall feed regularly to the cloth or paper to whose varnished surface it is to be attached.

Flock-pa'per. Wall-paper on which pulverized wool is attached by size.

Flog'ging-chis'el. A chipping-chisel of large size, used in chipping off certain portions of a casting.

Flog'ging-ham'mer. A hammer used by machinists, etc., intermediate in size between the sledge and hand hammer.

Flood-fence. 1. One anchored to prevent its being upset, floated off, or carried away during time of high water; or,

2. One which is laid over by the force of the current, and is prevented by its moorings from being carried away.

Flood-flank'ing. (*Hydraulic Engineering.*) A mode of embanking with stiff, moist clay, which is dug in spits, wheeled to the spot, and then each spit, separately being taken on a pitchfork, is dashed into its place so as to unite with the spit last thrown. The crevices which appear after the contraction of the clay in drying are filled by *sludging.*

Flood-gate. 1. A tide-gate or sluice.

2. *a.* A gate or sluice-door in a water-way, arranged to open when the water attains a hight above a given level, and so allow it to escape freely, to prevent injury by flood.

b. A gate which lies down when the stream becomes deep and powerful, so as to avoid being carried off.

Systems of irrigation including flood-gates, wheels, and pumps, were introduced into Spain by the Saracens. The country is gradually drying up. In the time of Pliny it was more populous and prosperous than now. Since the time of Abderrahman it has become still more dry and sterile.

Flook'an. (*Mining.*) The shifting of a vein or lode by a cleft. *Flooking.*

Floor. 1. (*Building.*) The surface on which a person walks in a room or house.

It may be of masonry, bricks, tiles, concrete, earth, boards.

The term usually refers to boards laid tightly together and nailed to timbers which are termed *joists.*

A *single-floor* (*A*) is one in which the joists *a a* pass from side to side of the house, resting upon wall-plates and sustaining the floor above, and the ceiling of the room below.

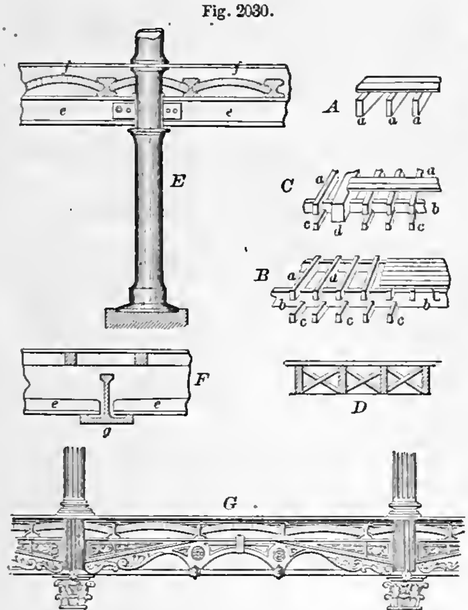
A *double-floor* (*B*) is one in which the primary timbers are binders *b b* which rest upon the wall-plates and support the *floor* or *bridging-joists a a* and the *ceiling-joists c c*.

A *framed floor* (*C*) has an additional member, which assumes the primary position. The *girder d* rests on the *wall-plates* and supports the *binding-joists b*, whose ends rest thereupon. The *binding-joists* support the *bridging* or *floor-joists a* and the *ceiling*-joists *c*, as before described.

Diagonal cross-pieces nailed between the top of one joist and the bottom of the next are called *struts*, and the floor is said to be *strutted* (*D*). The effect is to prevent the lateral deflection or tilting of the joists, and to make them mutually sustaining when an excessive weight is imposed on one or more.

Fire-proof floors (*E*) are usually constructed with iron girders *e* a short distance apart, which serve as

Fig. 2030.



Floors.

abutments for a series of brick arches *f*, on which either a wooden or plaster floor may be laid.

F is a floor with beams *c* supported on iron girders *g*. *G* is a fire-proof floor of brick and cement, supported on iron framing on iron columns. Over the cement is a wooden floor for comfort. It is from the Harpers' establishment in New York.

See also STABLE-FLOOR.

A *folding-floor* is one in which the heading-joints of a number are in a straight line.

In a *straight-joint* floor, each board breaks the joint of the preceding.

A floor without girders, joists, or pillars was laid in Amsterdam for a room sixty feet square. Very strong wall-plates were secured in the walls, and the floor consisted of three thicknesses of one and a half inch boards nailed to the wall-plate. The first two courses were separately laid and nailed diagonally across the space and crossing each other at right angles. The next course was laid in the usual manner, square with the building. The floor was thus suspended, and strained from the wall-plates.

Among the modes of constructing fire-proof floors may be cited girders and beams of cast-iron and trusses of wrought-iron. (See BEAM.) Spanning the intervals between the beams, brick arches are placed, and upon these concrete floors, with a simple covering of boards for comfort or appearance.

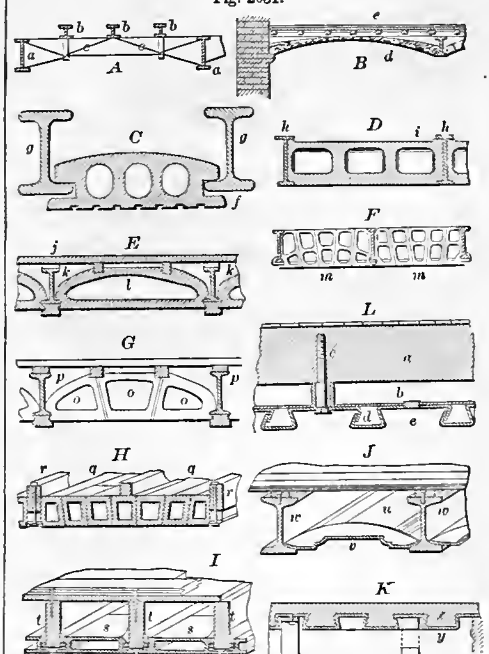
Fig. 2031 shows a number of modes of construction.

A has a truss of three members resting on I-shaped iron girders *a*, and supporting similarly shaped joists *b*, on which a floor is laid.

B has a sprung arch *d* of concrete or béton resting on a skew-back on the wall and the foot flange of the iron girder. On it rest the joists and flooring *e*.

C has hollow bricks *f*, which are suspended from

Fig. 2031.



Fire-Proof Floors.

the foot flanges of the angle-iron girders *g*, and support the ceiling.

D has blocks *i* of cement, concrete, or plaster-of-paris cast on temporary molds between the beams *h* and around cores.

E has arched and hollow tiles *l* which rest on the beams *k* and support the floor *j*.

F has hollow tiles *m* which meet above and below the beams. The tiles are in two tiers, and their thrust is sustained by a tension-rod.

G has arched tiles, three voussoirs *o* in a set, and these rest on the beams *p*.

H has five voussoirs *q* forming a flat arch resting on the beams *r*.

I has ceiling tiles *s* suspended from cleats on the ribs *t*.

J has I-shaped girders *w* supporting tiles whose soffits have coffers and moldings.

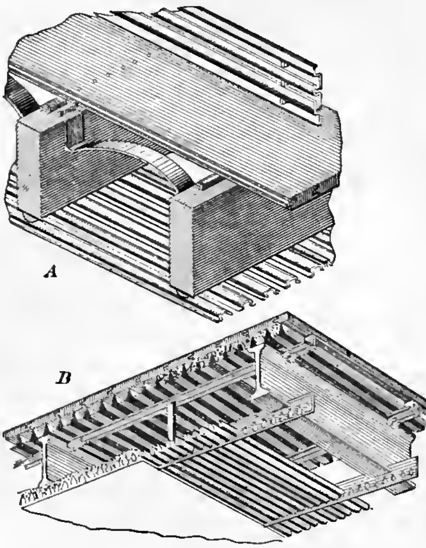
K is a roof in which the concrete surface *x* is held by corrugated plates *y* tied to the rafters *z* by angle-pieces.

L is a similar arrangement for ceilings; *a* the joists, *c* the suspension bolt, *b d* the sheet-iron, *e* the plaster.

In Fig. 2032, *A*, the joists have iron lath, and strips of metal are spiked to the joists to support arches of concrete beneath the flooring. The studding has also metallic lath.

B has girders of iron, with metallic plates for holding the ceiling laths, which are completely covered by the plaster. The floor rests upon concrete bedded upon corrugated plates, and these rest upon transverse cross-plates which tie the girders together.

Fig. 2032.



Fire-Proof Floors.

2. The bottom part of the hold on each side of the keelson. The flat portion of a vessel's hold.

3. The inner piece of the two which together form the bucket of an overshot water-wheel. See BUCKET.

Floor-cloth. 1. A heavy painted fabric for covering floors.

The canvas or backing of floor-cloth is a strong textile fabric of hemp or flax, known as *burlaps*. It is woven of a width of from four to eight yards. The pieces of convenient size are stretched in a vertical frame, and size is applied by workmen who stand on ranges of scaffolding in front of the canvas.

It is pumice-stoned to remove asperities. The color for the back is a thick paint laid on with a peculiar trowel. The front is then sized, pumiced, and receives several coats of paint. The pattern was at first stenciled, but since 1780 has been put on with blocks about 18 inches square, one for each color, and the blocks *register* with each other as in calico-printing or paper-staining. The canvas is spread upon a large table. Each block in turn is dipped face downward upon a cushion wetted with paint of the particular color for that block. A layer of paint is thus taken up and transferred to the canvas, as in printing. The colors are applied one by one, occupying their proper places in the pattern, which is made of little square types answering to the pattern and the color.

The *printing-table* is 30 feet long and 4 wide; the roll of painted cloth is underneath it, and is gradually unwound, passing over the surface of the table where the printing-blocks are applied. As it is printed, the cloth slips over the table and hangs down through a slit in the floor, so that it may remain vertical while the paint is drying.

A United States patent has been granted for a printing-block in which each square is represented by a square prism in a chase of the requisite size, say 18 × 18 inches. Each prism is separately movable and may be set out to the plane of the face. Any set of the prisms may be forwarded according to the pattern required.

The art originated with Nathan Taylor, in England, in 1754, at Knightsbridge, near London.

The canvas for the purpose was originally made of ordinary width and the strips sewed together. It was afterwards woven four yards, then seven yards, and eventually nine yards wide.

At the original Knightsbridge factory it is now made in pieces 8 × 20 yards and 7 × 30 yards.

2. An artificial fabric painted, varnished, or saturated with a water-proof material. The kinds are numerous; e. g.: —

Whiting and ocher, mixed with glue dissolved in milk.

Leather scraps treated with alkali, ground, mixed with flax or hemp fiber, and rolled into sheets.

Cotton batting treated with a cement of beeswax, glue, venice turpentine, and boiled linseed oil; covered with a pigment of burgundy pitch, litharge, and boiled linseed oil, colored to suit.

Wall-paper varnished.

Wall-paper on canvas, sized and varnished.

Painted cloth.

Sheets of rubber and cork dust, softened with benzole rolled between two fabrics, a coarse and a fine; the latter is stripped off, leaving the composition attached to the other.

Painted paper.

Duck treated with boiled oil, resin, and cork dust, or saw-dust. Varnished.

Paper printed in oil and varnished with solution of caoutchouc.

Cloth varnished.

Manila paper on both sides of burlaps.

Fabric coated with paper-pulp in the machine.

Roofing-paper treated with warm linseed oil and naphtha, to which is pasted a sheet of wall-paper, varnished.

Burlaps, sheared, damped, calendered, printed.

Paper floor-cloth treated with varnish, having in it powdered felspar or glass.

Fabric covered with paper, treated with oil, resin, and japan varnish. Ornaments of water-color placed thereon and fixed with white glue.

Jute and manila grass combined and colored in stripes.

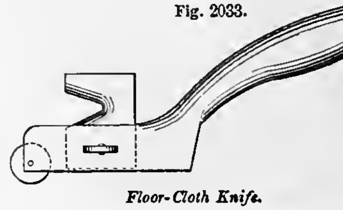
Fabric coated with ground slate or clay; with linseed oil, japan varnish, and paints.

Ground leather, vegetable fiber, and bullock's blood or fibrine, painted, stained, or printed.

Jute fiber printed with aniline.

Canvas sized with glue and painted.

Fig. 2033.



Floor-Cloth Knife.

Lamina of wood backed by fabric or paper.

Paper cemented on cloth, printed or grained, and varnished.

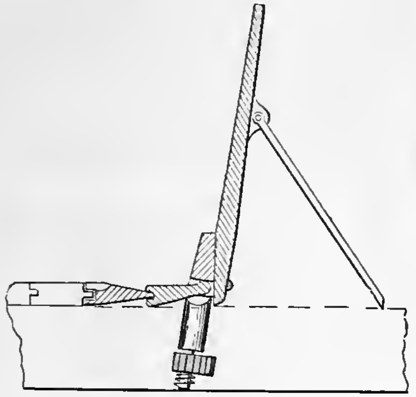
See also LEATHER, ARTIFICIAL.

Floor-cloth Knife. A pushing knife for slitting floor-cloth. The caster keeps it above the floor.

Floor-head. (*Shipbuilding.*) The upper extremity of a floor-timber.

Floor'ing-clamp. An implement for closing up the joints of flooring-boards. In the example, the clamp straddles the joist; is retained by the serrated

Fig. 2034.



Flooring-Clamp.

cams, and the forward thrust of the lever is maintained by a pivoted brace, which engages the joist behind it.

Floor-plan. 1. (*Shipbuilding.*) A longitudinal section, showing the ship as divided at a water or rib-band line.

2. (*Architecture.*) A horizontal section, showing the thickness of the walls and partitions, the arrangement of the passages, apartments, and openings at the level of the principal or receiving floor of the house.

Floor-tim'ber. (*Shipbuilding.*) The lower section of a rib secured between the keel and *keelson*, the flat timbers crossing the keel forming the floor of the hold. The timbers in continuation of the rib are called first, second, third, etc., *futtocks.*

Flop-damp'er. A stove or furnace damper which rests by its weight in open or shut position.

Flo'ran. Fine-grained tin; either scarcely perceptible in the stone or stamped very small.

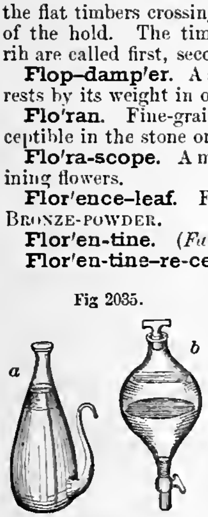
Flo'ra-scope. A microscope contrived for examining flowers.

Flor'ence-leaf. Fine leaf yellow alloy. See BRONZE-POWDER.

Flor'en-tine. (*Fabric.*) A kind of silk.

Flor'en-tine-re-ceiv'er. A form of receiver (*a*) for the results of the distillation of essential oils. It is conical in form, and has a side spout at which accumulated water discharges as it rises to the level of the bend of the spout, while the oil, which is lighter than water, collects at the top, and may be decanted off.

Fig 2035.



Florentine-Receiver.

Oils heavier than water are collected in the separator *b* and drawn off at bottom.

Flor'et-silk. FLOSS-SILK (which see).

Flosh. (*Metallurgy.*) A hopper-shaped box in which ore is placed for the action of the stamps. The side of the box has a shutter which is raised or lowered to allow the ore to escape when it has acquired the desired fineness.

Floss. Fluid glass floating in a puddling-furnace.

Floss-hole. (*Metallurgy.*) *a.* A hole at the back of a puddling-furnace, beneath the chimney, at which the slags of the iron pass out of the furnace.

b. The tap-hole of a melting furnace.

Floss-silk. The exterior soft envelope of a silk-worm's cocoon; the raveled downy silk broken off in the filature. It is carded and spun for various purposes.

Floun'der. A slicking-tool whose edge is used to stretch leather for a boot front in a *blocking* or *crimping board.*

Flour-bolt. (*Milling.*) A gauze-covered revolving, cylindrical frame or reel, into which *meal* or *chop* from the stones is fed, in order to have the flour sifted through and separated from the offal. The cylinder is large and long, and its axis is usually inclined; the bolting-cloth with which it is covered is of different grades of fineness, the meshes at the reception end being closer than towards the discharge. The matters passing through at the different portions of the length are of different grades, and are kept separate.

The "fine-flour" of Scripture was doubtless bolted flour, in contradistinction to unbolted flour or brown meal.

Pliny speaks of sieves of horsehair as first made by the Gauls, and those of linen by the Spaniards. The method of applying "a sieve in the form of an extended bag to the works of a mill, that the meal might fall into it as it came from the stones, and of causing it to be turned and shaken by the machinery, was first made known in the beginning of the sixteenth century" (BECKMANN). The best bolting-cloths used in Germany, when Beckmann wrote, came from England, and were made of wool.

Flour-cool'er. (*Milling.*) A chamber, trunk, or machine in which meal from the stones is placed to cool, or is stirred by a blast before arriving at the bolt.

Flour-dress'ing Ma-chine'. The flour-dressing machine is a hollow, stationary, inclined cylinder or frame covered with wire cloth of different degrees of fineness, 64, 60, 38, and 16 meshes to the inch, the finest being at the upper end. Within the cylinder is a reel whose rails are covered with brushes, which, in their revolution, act against the interior wire surface of the cylinder. The meal is conducted within the cylinder by a spout or hopper, and is thus rubbed through the wire meshes, the finest at the top, the next at the succeeding grade, and so on. The various qualities are collected in the separate partitions of the box.

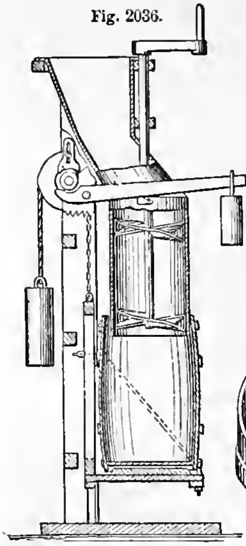
The machine is described in the patent of John Milne, 1675.

Flour-mill. See GRINDING-MILL.

Flour-pack'er. A machine for compactly filling barrels or bags with flour. It is usually a follower or piston which presses upon the flour, but in some cases the flour as it falls into the barrel is continuously packed by a spiral, as in the example.

The barrel is placed on a platform suspended by a steelyard and by a weighted cord passing over a pulley. The steelyard takes under and clamps another pulley attached to the former one, driving it against a block above. On sufficient deposit of flour the steelyard is depressed, the roller freed

Fig. 2036.

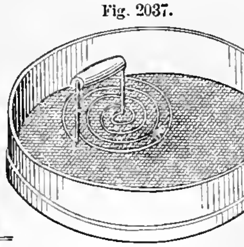


Flour-Packer.

from the upper brake, and the barrel of flour descends.

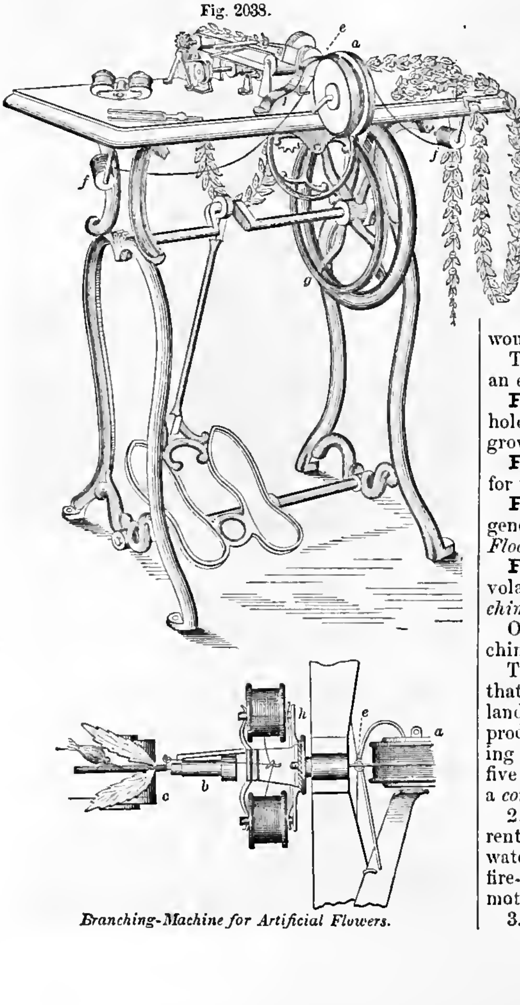
Flour-sift'er. A domestic sieve for separating lumps or accidental trash, such as insects, from the flour of the bin or barrel. As a substitute for the hands, a flat coil of silvered wire is adapted to vibrate over the meshes of the sieve and expel the flour.

Fig. 2037.



Flour-Sifter.

Fig. 2038.



Branching-Machine for Artificial Flowers.

Flow'ers, Ar'ti-fi'cial. Ornaments simulating the natural products of the garden; made from wire, gauze, cloth, paper, shavings, wax, shell, feathers, etc. Cutting-punches and scissors are used for shaping; gauffering-presses for stamping into the various graceful shapes and puckers.

The feather-flower makers of South America and Mexico had attained great skill in the time of Cortes. Italy led the way in Europe; France followed, and now leads.

Fig. 2038 shows a French machine for branching artificial flowers, that is, braiding them or leaves to a stem.

The basis of the stems is wire, and two threads of suitable material are laid along this wire to prevent subsequent slipping of the colored thread, which forms the outer covering of the stems. The ends of the short stems of leaves, flowers, buds, and fruits being laid against the wire are wound under the outer covering, and are thus fastened to it.

The wire is fed from a spool *a*, passes through a hollow spindle *b*, and lies upon an endless feed-belt *c*, to which it is clamped by small pinchers.

The belt is driven by gearing underneath, and carries with it the wire stem, which is slowly unwound from the spool *a*. Two threads, passing through an eye *e*, are also drawn through the hollow spindle *b*, in conjunction with the wire, by the motion of the endless belt. These threads are unwound from the spools *f*. At the same time a rapid rotary motion is given to the hollow spindle by a small belt from the driving pulley *g*.

On the revolving hollow spindle *b* is fixed a spool-frame *h*, which carries two spools. The covering threads are led from these spools through the loop of a small flyer on the end of the hollow spindle *b*, and being held in contact with the wire as the latter is slowly fed through the spindle, are wound uniformly over its surface, the spool-frames revolving with the spindles.

The ends of the stems of leaves, fruits, or flowers being thrust into the ends of the hollow spindle are at once caught, and firmly wound under in a rapid manner.

The upper figure is a general view, and the lower an enlarged view of the principal working parts.

Flow'er-pot. A flaring earthenware vessel to hold a plant with a sufficient quantity of soil for its growth.

Flow'ing-fur'nace. (*Founding.*) Another name for the cupola for melting iron in foundries.

Fluc'can. (*Mining.*) A soft, clayey substance, generally accompanying the cross-courses and slides. *Flookan.*

Flue. 1. A passage for the conveyance of the volatile results of combustion. A *smoke-duct* or *chimney*. See FIREPLACE; CHIMNEY.

One of a cluster of smoke-ducts in a stack of chimneys.

The longest flue with which we are acquainted is that of the lead-furnaces, Allen Mill, Northumberland, England. It is used for cooling the volatile products of combustion, and condensing the escaping lead fumes. It is 8,789 yards in length (nearly five miles), is 8 feet high, 6 wide. It may be called a *condenser*, so far as the fume is concerned.

2. A pipe for the conveyance of the caloric current through a boiler, to heat the surrounding water. It is usually secured in the sheets of the fire-box and smoke-box respectively, as in the locomotive-boiler. Perhaps invented by Smeaton.

3. The technical abbreviation of *flute;* used by

organ-builders to signify a *flute-pipe*, in contradistinction to a *mouth-pipe* or *reed-pipe*.

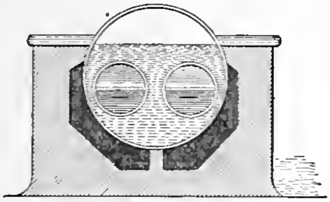
Flue-boil'er. A steam-boiler whose water space is traversed by flues; that is, a tube in which the heated gases are conveyed. There are several varieties, as, *drop-flue; multiple-flue; return-flue*, etc.

Smeaton is credited with the invention. It is now the usual form on our Western rivers; the cylindrical boilers have usually two flues. The fire heat first passes beneath the boiler, and then returns through the flues.

The term *flue*, properly used, distinguishes the boiler from those which have *tubes*, which are full of water, and the heat *surrounds* them, but does not *fill* them.

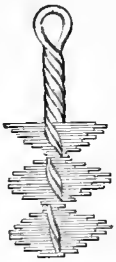
In the boiler represented, the fire is built *in* the flues, and the caloric current returns beneath the boiler.

Fig. 2039.



Fairbairn's Flue-Boiler.

Fig. 2040.



Flue-Brush.

Flue-brush. A cylindrical brush of wire or steel strips used to clean the scale and soot from the interior of a flue, to lay bare the metallic surface.

Flue-clean'er. A brush of wire or steel slips, or a scraper to clean flue surfaces of steam-boilers.

A device by which a jet of steam may occasionally be projected along a boiler flue to blow out the scale of soot.

Flue-ham'mer. (*Coopering.*) One whose *peen* has a working edge, the length of which is in the plane of the sweep of the hammer. It is used in flaring one edge of each iron hoop to enable it to fit the *bulge* of the cask. See PEEN.

Flue-plate. A plate into which the ends of the flues are set.

Flue-scrap'er. An implement having circular or spiral blades to scrape the scale from the fire-surface of flues of steam-boilers.

Flue-sur'face. (*Steam-engine.*) The area of surface of the boiler which is exposed to the action of the flame and heated gases after they have left the fire-chamber or furnace.

The heating surface of a boiler is made up of the *fire-surface* and *flue-surface*.

Fluid-com'pass. (*Nautical.*) That in which the card revolves in its bowl floated in alcohol.

Fluid-lens. One in which a liquid is imprisoned between circular glass disks of the required curvatures.

Attempts to obtain achromatism have been made by using metallic solutions and other liquids having a higher dispersive power than flint glass. Though several of these liquids appear to have given excellent results experimentally, they have never been brought into general use.

Fluid-me'ter. A device to ascertain the quantity of fluid passing a selected point.

Some of these are driven by clock-work or other motor, others by the pressure of the fluid. When this is an elastic body, as air or gas, the question is complicated by the compressibility; when the fluid is such as water, alcohol, or oil, the problem is more simple. See LIQUID-METER.

Among fluid-meters proper may be cited GAS-METERS (which see). As to mechanical construction, they may be described as fans rotating spiral vanes, expanding bags, cylinder and piston, revolving partially submerged meter-wheels, inverted cylinders. See AIR-HOLDER, etc.

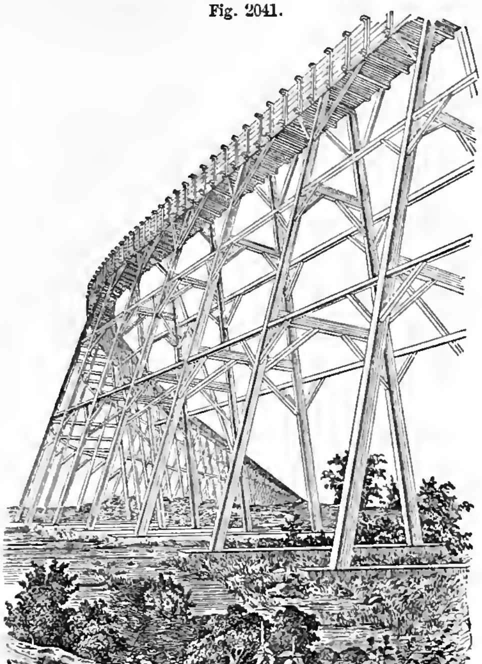
Fluke. 1. (*Nautical.*) The palm of an anchor. The broad, holding portion which penetrates the ground. See ANCHOR.

2. (*Mining.*) The head of a charger: an instrument used for cleansing the hole previous to blasting.

Flume. A chute or penstock, open or covered, for the passage of water to a wheel or washer. Used with water-wheels and gold-washers of various kinds. A *penstock*.

The illustration shows a flume crossing a valley

Fig. 2041.



Flume near Smartsville, Yuba County, California.

in California, uniting the feeder canal on one ridge with the distributing canal of another ridge.

Flu'or-o-type. (*Photograph.*) A process into which fluoric acid enters in the shape of fluorate of soda.

Flush. 1. A term signifying an unbroken or even surface, or applied to surfaces on the same plane.

2. To turn on a sudden dash of water. See FLUSHING.

Flush-bolt. *a.* A screw bolt whose head is countersunk so that it shall not protrude from the surface of the object.

b. A sliding bolt let into the face or edge of a door so as to make an even surface therewith.

Flush-deck. (*Nautical.*) One running the whole length of the vessel, from stem to stern, without forecastle or poop, as in a frigate. The "Great

Eastern" has a flush-deck 692 feet long and 83 feet wide.

Flush'ing. 1. (*Hydraulic Engineering.*) To turn on a sudden and copious dash of water as in *flushing a sewer* to cleanse it of silt. When a collected body of water is turned into the channel of a harbor to deepen it and keep it navigable, it is termed *sluicing;* the *sluice* being opened to let the water out of the reservoir. Where the water of a river is dammed to obtain a fall, and the head of water is turned through a sluice-way to increase the depth of water at that point to float a boat on to another level, it is termed *flashing.*

When the water from a dam is suddenly turned by a sluice-way down a ravine, to turn up the earth and stones and expose ore, it is called *hushing.*

2. (*Weaving.*) A term applied to a thread which spans a number of other threads without intersection. (See TWILL.) Usually called FLOATING (which see).

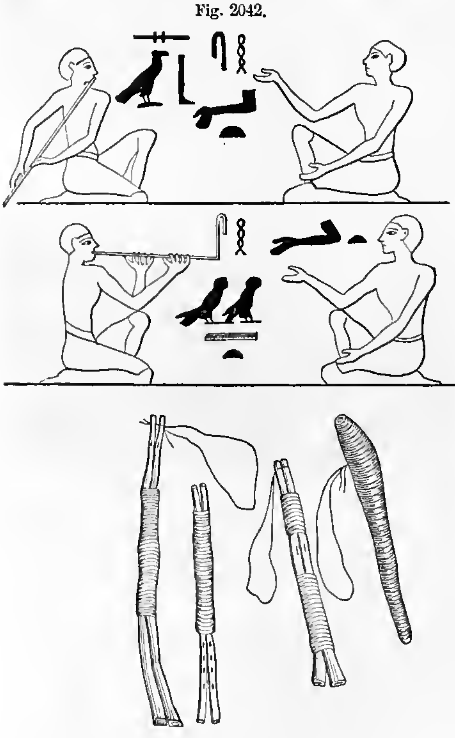
Flush-joint. One in which the abutting parts make no projection beyond the general face of the object.

Flush-pan'el. (*Joinery.*) One whose surface comes out even with the face of the stile.

Flush-wheel. A wheel used in raising water for draining; it is shaped like a *breast-wheel,* but is driven by power to raise water. See SCOOP-WHEEL.

Flute. 1. (*Music.*) An ancient wind instrument which had several forms in ancient times, which it still maintains among savage nations. The New-

Fig. 2042.



Flutes of ancient Egypt and of Brazil.

Zealanders play it with a blast through the nose. In some barbarous countries it has two barrels. The mouth-piece is generally at the end, like our clarinet. Captain Speke found one of the native kings of Equatorial Africa proficient after his style.

The instrument called a flute in the translation of the Book of Daniel may have been the pandean pipes, which are very ancient, or it may have been the flute as used in Egypt.

The flute is very common in the paintings of the Egyptian tombs. The accompanying cut is from a painting in a tomb near the Pyramids. The action indicates the side position of the mouth-pieces and holes. Of the chromatic scale we may learn more from what Pythagoras has written, for no doubt he derived his information from the Egyptian priests, who were scientific musicians.

The flutes of ancient Egypt were single and double; the latter are shown on the paintings of Eléythya. In one case the flute is apparently blown through the nostril, like the New Zealand flute.

Herodotus (450 B. C.) mentions the marching of the troops of Alyattes the Lydian "to the sound of pipes and harps, and flutes masculine and feminine." This has been understood to refer to the sexes of the players, but more probably indicates lower and higher musical pitch.

Flutes among the classic Greeks were made of asses' bones, which are said to be remarkably solid. The euphony of the sound may be presumed to be in the inverse ratio of the natural tone of the original proprietor.

The same much-belied animal contributes his hide to the making of drum-heads, which have a fullness of tone highly suggestive of the inflated style of the creature

"Out of whose mouth there issues a blast."

See DRUM. The *ossea tibia* was made of the leg-bone of a crane.

Alcides *loquitur:* —

"The Alexandrians are especially skillful with the flute; and not only in those kinds called girl's flutes and boy's flutes, but also in men's flutes, which are also called perfect and super-perfect; and also in those which are called harp-flutes, and finger-flutes. For the flutes called *elymi,* which Sophocles mentions in his 'Niobe,' and in his 'Drummers,' we do not understand to be anything but the common Phrygian flute. And these, too, the Alexandrians are very skillful in. They are also acquainted with the flute with two holes, and also with the intermediate flutes, and with those called *hypotreti,* or bored underneath.

"We know of some that are called *half-bored,* which Anacreon mentions: —

'What lust has now seized thus upon your mind,
To wish to dance to tender half-bored flutes?'

And these flutes are smaller than the perfect flutes. I am acquainted, too, with other kinds of flutes, the tragic flute and lysiodic flute [used by the actor personating a female] and the harp-like flute; all which are mentioned by Ephorus in his 'Inventions,' and by Euphranor the Pythagorean in his 'Treatise on Flutes,' and also by Alexon, who wrote another treatise on 'Flutes.' But the flute called *tityrinus* among the Dorians in Italy, and the flute *magadis* [a Lydian instrument], sends forth a sharp and a deep note at the same time, as Anaxandrides says in his 'Armed Fighter': —

'I will speak like a *magadis,* both loudly and gently.'

And the flutes called *lotus-flutes* are the same which are called *photinges* by the Alexandrians; and they are made of wood growing in Libya. But Juba says that the flute which is made out of the leg-bones of the kid is an invention of the Thebans; and Tryphon says that those flutes which are called *elephan-*

tine [ivory] were first bored among the Phœnicians." — *Deipnosophists*, by ATHENÆUS, A. D. 220.

"The Phrygian *deep-toned flute* had a bell mouth, like a trumpet." — *Ibid.*

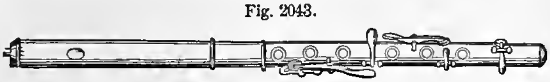
So they had no lack of flutes and writers on the same 2,000 years ago.

Flutes are extensively made and used by the Brazilian natives. The bones of which they are made are yellow, jagged, and far from inviting to delicate lips. Their tones, however, are singularly soft and mellow. The largest has two bones, each 12 inches long and ⅜ inch bore. They are united by twine neatly wound and worked. On the back of the lower part are finger-holes, shown in Fig. 2042. The whistle part is constructed by a cone of resinous cement beneath the mouth-orifice, the ridge of cement rising to the center of the tube. The instrument is played by blowing through the upper end, as in a clarinet. A smaller flute is made to play by blowing in at either end. Another has a swelled, wooden mouthpiece, and no side opening. Dual bone-flutes with finger-holes are yet used in the northern provinces of Brazil; besides bamboo flutes and instruments, with which the voices of wild beasts are imitated with singular accuracy.

The Peruvians, among a multitude of musical instruments, had flutes of various sizes, the tambourine, and the *tinga*, a kind of guitar with five or six strings. They had also a *syrinx*, or pan's reed, with eight pipes, — one more than the classical and the modern.

The flute, as we now know it, was long known as the *German flute*, having one end closed by a plug, the mouth-orifice being on the side. The common varieties of this flute have six open holes and a seventh closed by a key, as in oboes, bassoons, etc.

Fig. 2043.



Flute.

Flutes are now made with from seven to ten keys, by which the fingering of many musical passages is much facilitated.

Flutes are made of hard wood, ivory, glass, metal, or vulcanized rubber.

In the Smithsonian Institute, Washington, is a Guiana native flute made of the thigh-bone of a tiger.

Vaucanson's automaton flute-player was a life-sized figure dressed in the habit of the period (1730), and standing on a pedestal. The figure and the stand were filled with the machinery. The figure was wound up with a key, and played music on a real flute. Air was emitted at the mouth of the figure and projected into the mouth-hole of the flute. The force of the blast was proportioned to the loudness or softness required, and we presume the size and perhaps shape of the embouchure formed by the lips was varied according to the pitch and perhaps the timbre. The details of the invention in this respect have not come down to us. The fingers were made of some elastic material, and were made to stop the holes in the order required. The compass of the machine is not stated, nor the number of tunes within its repertoire.

In a flageolet-player subsequently made by the same artist, the number of holes was but three, and the variation of the pressure on the bellows was from one ounce for the lowest to fifty-six pounds for the highest.

About 1820 two automaton flute-players were exhibited in London. They played eighteen duets.

2. (*Architecture.*) *a.* A long vertical groove in the shaft of a column.

It is usually circular in section, but, when angular, the shaft is called a *canted* column.

The Doric column has twenty flutes.

The Corinthian, Ionic, and composite have each twenty-four flutes.

The Tuscan none.

b. A hollow, concave chamfer, gutter, groove, or channel; the receding member of a compound molding.

3. A species of ruffle.

4. A *stop* in an organ.

Flute-bit. A wood-boring tool adapted to be used in a brace, and used in boring ebony, rosewood, and other hard woods. See BIT; BORING.

Flute-or'gan. (*Music.*) An organ in which the sound is produced by the action of wind on a cutting edge, in contradistinction to the *reed-organ*, in which the sound is produced by a vibrating tongue of metal. See REED-ORGAN.

The *flute-pipe* has a hollow *foot* to conduct the wind to the *body*, which is fastened thereto. Between the *foot* and the *body* is a diaphragm with an aperture through which the wind escapes, coming in contact with the upper lip of the mouth and being set in vibration, thereby causing the sound. As in the flute, the quality of the sound is governed by the proportions of the pipes.

The pipes are made of metal or wood, are generally cylindrical and open at the end.

The wooden pipes are square in section, their ends being stopped with *tompions*, whose distance from the lip modulates the tone, as in the flute.

The longer the pipe the graver the sound, — like the flute again, as may be observed by blowing it after stopping all the side holes in the flute with the fingers, and again after raising the fingers.

The *flute-organ* is also called the *mouth-organ*, and the *mouth* or *flute pipes* are technically known as *flues*; a contraction of *flutes*.

Flute-pipe. (*Music.*) An organ-pipe having a sharp lip or *wind-cutter* which imparts vibrations to the column of air in the pipe, producing a musical note. See MOUTH-PIPE.

Flute-stop. (*Music.*) A stop of an organ in unison with principal, and tuned one octave above *open-diapason*. See STOP.

Flu-ti'na. A kind of accordeon resembling the concertina.

A form of melodeon. An instrument worked by a bellows and keys in bank, and having one set of reeds.

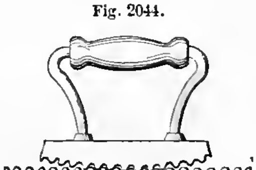
Flut'ing. 1. A species of ruffle.

2. One of the longitudinal grooves in a screw-tap, giving cutting-edges to the thread. See FLUTE.

Flut'ing-cyl'in-der. One having longitudinal grooves to corrugate, crimp, or flute thin sheet-metal plates or fabrics.

Flut'ing-i'ron. A species of laundry-iron which flutes the clothes. In the example, the iron has a segmental corrugated face, and works upon a flat corrugated bed.

Fig. 2044.

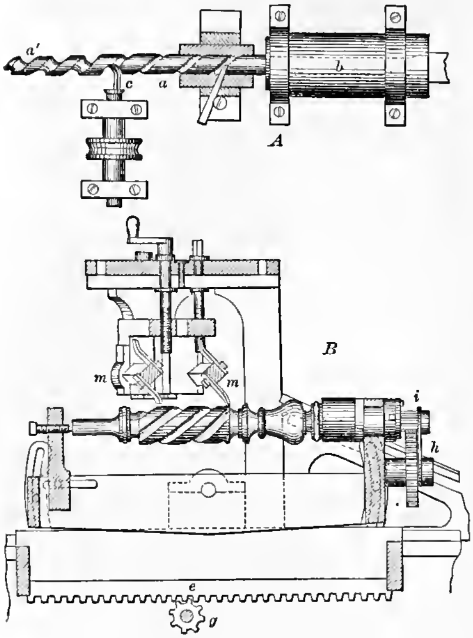


Fluting-Iron.

An *Italian*-iron; a *gauffering*-iron.

Flut'ing-lathe. One which cuts flutes or scrolls upon columns or balusters. The *flute* proper is the vertical groove in a column or pillar, but the flute of the lathe is a spiral. Several forms of machines are adapted to this purpose. One is allied in its principle to the rifling-machine, as in January's patent, 1829. The baluster is fed endways against a lateral tool, being rotated on its axis at such a rate as shall impart the number of turns or part of a turn to the foot in length. Of this kind is Fig. 2045 (*A*), in which the piece *a*

Fig. 2045.



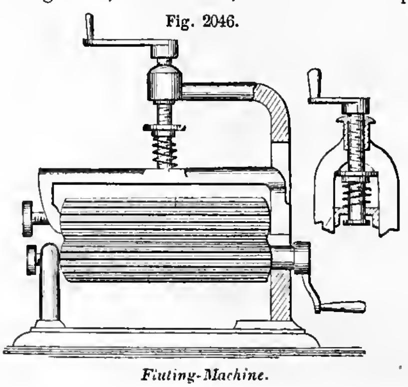
Fluting-Lathes.

to be cut is moved longitudinally through the holder *b*, and at the same time is rotated so that the tool *c* in its revolutions may cut the spiral groove shown at *a'*.

B is a fluting-lathe in which a pair of cutters revolves in a plane oblique with the line of motion of the baluster. The latter is moved longitudinally by the rack and pinion *e g*, and rotated by the wheel and pinion *h i*; the cutters *m m* rotating in parallel planes cut two groves at once.

Flut'ing-ma-chine'. One having a pair of rollers, each one having projections which enter the interdental spaces of the other. By turning the operating screw, the bent bar, and with it the upper roller, can be adjusted up or down at will to regulate the distance between the two rollers.

Fig. 2046.

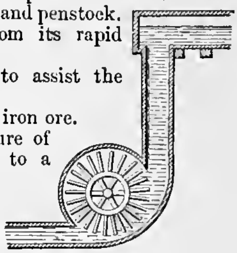


Fluting-Machine.

Flut'ing-plane. (*Joinery.*) A plane adapted to cut grooves.

Flut'ter-wheel. A water-wheel of moderate diameter placed at the bottom of a chute so as to receive the impact of the head of water in the chute and penstock. Its name is derived from its rapid motion.

Fig 2047.



Flutter-Wheel.

Flux. A salt added to assist the fusion of a mineral.

Limestone is used with iron ore.

Crude flux is a mixture of niter and tartar added to a metal in the crucible.

White flux is obtained by projecting, in small portions at a time, equal parts of niter and tartar into a red-hot crucible.

Black flux has double the proportions of tartar, and the resulting product is dark colored.

Mowean's flux consists of pulverized glass, 16 parts; calcined borax, 2 parts; charcoal, 1 part.

Lime acts as a flux, when in excess, in brick-making.

Lime, soda, potash, lead, borax, are used as fluxes in glass-making.

Fluor-spar is used in certain metallurgic operations.

The fluxes used by solderers are, —

Borax.	Venice turpentine.
Sal-ammoniac.	Tallow.
Chloride of zinc.	Gallipoli oil.
Resin.	

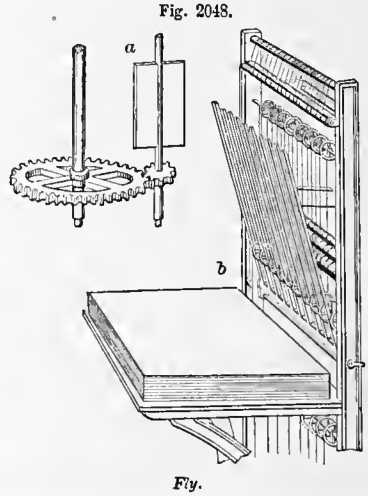
Flux-spoon. (*Metallurgy.*) A small ladle for dipping out a sample of molten metal to be tested.

Fly. 1. (*Horology.*) A regulating device (*a*) used formerly in clocks, and latterly in musical boxes, to control the rate of speed.

The vanes impinge upon the air and meet with a resistance depending upon their area, radial width, angle, number, and speed. By changing these conditions, or any of them, the rate of going of the machine may be regulated; the resistance of the air increasing in a very rapid ratio.

The device is still used in the striking parts of clocks and watches.

Fig. 2048.



Fly.

In musical boxes the position of the wings is adjustable, so as to vary their angle of impact upon the air, thus increasing or diminishing the resistance of a given surface of wing and modifying the speed.

This regulator was probably the first device attached to the going works of a clock, many centuries before the oscillating arm or the pendulum were adapted to the purpose. See PENDULUM.

Among the clocks thus regulated may be cited that of Richard of Wallingford, abbot of St. Albans, A. D. 1380. It is likely that the clock erected in the Old Palace-Yard, London, in 1288, and that of Canterbury Cathedral, A. D. 1292, were similarly constructed. To go a step farther back, we may suppose that the clocks presented by Pope Paul I. to Pepin of France, A. D. 760, and to Charlemagne by the Caliph Haroun Al Raschid, A. D. 810, were of similar construction ; or perhaps were clepsydras.

2. (*Printing.*) A vibrating frame *b* with fingers, taking a printed sheet from the *tapes* and delivering it on to the heap.

3. (*Knitting-machine.*) Another name for the LATCH (which see).

4. (*Spinning.*) The arms which revolve around the bobbin in a spinning-frame, to *twist* the roving or yarn which is wound on the bobbin. See FLYER.

5. (*Machinery.*) A FLY-WHEEL (which see).

6. (*Weaving.*) A shuttle driven through the shed by a blow or jerk.

7. *a.* The length of a flag from the staff to the outer edge. The perpendicular hight is the *hoist*.

b. The part of a flag beyond the *jack*, which occupies the upper left-hand corner. See FLAG.

8. (*Nautical.*) A compass-card having marked upon it the points or rhumbs, thirty-two in number. The card is moved by a magnetic-needle beneath. The angle of the ship's course with the magnetic meridian is shown on the marginal plate by a line called the *lubber's line*. See MARINER'S COMPASS.

9. A kind of carriage ; usually a closed vehicle plying for hire and drawn by one horse.

10. A certain part of theatrical stage scenery.

11. The swinging weighted arm of some kinds of presses. See FLY-PRESS.

12. A factitious insect as a bait for fish in angling. A *hackle*.

Fly-block. (*Nautical.*) A large flat block, double or single. The double block sometimes has two sheaves at one part and one sheave in the other portion. Used in the hoisting-tackle of yards.

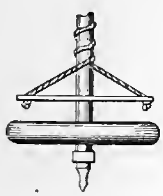
Fly-board. (*Printing.*) The board upon which the printed sheets are laid by the *fly*.

Fly-boat. 1. A rapid passenger-boat on canals.

2. A large, flat-bottomed Dutch coasting-vessel. An ironical term.

Fly-drill. One having a reciprocating fly-wheel which gives it a steady momentum. The driving power consists of a cord winding in reverse directions upon the spindle as it rotates first in one direction and then in the other.

Fig. 2049.



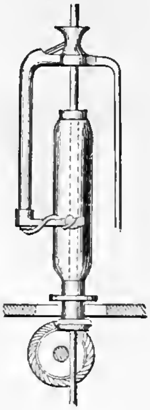
Fly-Drill.

Pressure on the end of the spindle keeps the drill to its work. The fly-wheel pulsates like the balance-wheel of a watch, and as it reaches each end of its stroke the cord has become wound on the spindle, so as to be ready to communicate the impulse in the other direction, by a pressure on the bar which unwinds the cord by rotating the spindle. A relaxation of pressure on the bar allows the spindle to pass beyond the point of unwinding, and the cord winds upon it in a reversed spiral.

This drill may be run by a bow.

Fly'er. 1. A contrivance with arms which revolves around the bobbin in the *bobbin and fly* frame, or the *throstle-frame*, which machines draw and twist the *sliver* into a *roving*, or the latter into *yarn*.

Fig. 2050.



Flyer.

The *flyer* fits on to the top of the spindle, and one arm (in the *bobbin and fly* frame) is made hollow to form a passage for the yarn, which enters at the cup above the top of the spindle, and after a turn or two round the end of the arm is distributed on the bobbin. In the throstle-frame the roving entering above is wound *round* the arm of the *flyer*, instead of passing *through* a *tubular* arm. See THROSTLE.

The flyer rotates with the spindle, and their rotation gives the twist to the yarn. The bobbin is independent of the spindle motion, but in roving-machines has a surface motion equal to the rate of delivery of the yarn from the drawing-rollers. See ROVING. The same also occurs in the BOBBIN AND FLY FRAME (which see).

In the *throstle*, the winding occurs by the detention of the bobbin, which rests on the *copping-rail*, the bobbin being dragged around by the yarn proceeding from the end of the *flyer*, the resistance to revolution on the part of the bobbin effecting the winding. See THROSTLE ; EQUATORIAL BOX.

2. The fan-wheel on the vane of a windmill cap which rotates the latter as the wind veers. See CAP.

3. A step in stairs that ascend in one inclined plane, without winding.

A straight reach of stairs. A *flight*.

4. (*Printing.*) A vibratory rod with fingers which take the sheet of paper from the tapes and carry it to the delivery-table, the sheet resting flatly against the flyer-fingers by the resistance of the air. See FLY.

Fly'er-lathe. (*Weaving.*) A *lay, lath*, or *batten* for beating up the weft into the shed, compacting it. Specifically, it may mean a suspended lathe, as distinguished from the batten in a frame journaled below.

Fly-gov'ern-or. One which regulates speed by the impact of vanes upon the air. A *fly*.

Fly'ing-ar-til'ler-y. Field artillery when the gunners are all mounted ; either on horses, or on the limbers.

Fly'ing-bridge. A temporary bridge, suspended or floating. A military, ponton, or boat bridge. See BRIDGE for varieties.

Fly'ing-but'tress. A structure spanning the roof of an aisle between an outer buttress and the wall of the nave. It assists in resisting the thrust of the roof.

Fly'ing-jib. (*Nautical.*) A sail extended by the flying jib-boom beyond the standing jib.

Fly'ing Jib-boom. (*Nautical.*) An extension of the jib-boom. It is sometimes in one piece with the latter, and sometimes connected therewith by means of a boom-iron, in a manner analogous to that of the jib-boom on the bowsprit.

Fly'ing-ma-chine'. To Dædalus, who is said to have flourished about 1300 B. C., is ascribed the invention of the first flying-machine. Being desirous of escaping from the wrath of Minos, king of Crete, and no method of sea conveyance presenting itself, he resolved to attempt flight through the air, and made accordingly wings of feathers united by wax for himself and his son Icarus. They ascended into the air, and Dædalus arrived safely in Sicily, but Icarus rose too high, and approaching too near the sun, the wax of his wings was melted, and, the uncemented fabric falling asunder, the rash youth fell into the sea and was drowned. Notwithstanding the multiplicity of attempts which have been made to accomplish the feat of rising above the earth by means of wings, Icarus remains a solitary warning of the danger of approaching too near to the sun.

Roger Bacon asserted in his time that there existed a flying-machine; he had never seen it himself, nor did he know any one who had seen it, but he knew the name of the inventor.

In 1709, Gusman, a Portuguese monk, constructed a machine in the form of a bird. He was pen-ioned for this, and was thus perhaps enabled to rise in the world, which his machine signally failed to do. Not discouraged, however, in 1736 he constructed a wicker basket covered with paper, which rose to the hight of 200 feet in the air, by which he gained at least fame, if not money, for he was afterwards reputed a sorcerer.

It was in 1783 that the Montgolfiers discovered that the lesser specific gravity of heated air created an ascensive force by which heavy objects might be raised through the atmosphere; and in less than a month afterwards hydrogen gas, which had then been known for about seventeen years, was successfully employed in a balloon for the same purpose.

This seemed to render the idea of aërial navigation more feasible, and accordingly Blanchard, one of the earliest aëronauts, on his first ascent from Paris in March, 1784, provided his balloon with wings and a rudder, but found them useless. After this we hear little of attempts to guide or propel balloons through the air until about 1843, when Mr. Monck Mason proposed the Archimedean screw as a motor, and constructed an egg-shaped balloon, which was placed on a wooden frame in the form of a canoe, with an Archimedean screw at one end and an oval-shaped rudder at the other. A model of this machine, set in motion by a screw moved by clock-work, was propelled around a room by this means; but the larger machine appears to have met the fate of all its kindred contrivances.

About the same time, a Mr. Henson, in England, patented a machine consisting of a car attached to a huge, rectangular, wing-like frame, covered with oiled silk or canvas, and to be propelled by a steam-engine in the car working two vertical fan-wheels with oblique vanes; while a frame like the tail of a bird was to act as a rudder, and make the apparatus ascend or descend at pleasure. It did not ascend.

In 1850, a Mr. Bell ascended from Kennington, England, in an "aërial machine" in the form of a prolate spheroid, which, it is said, he propelled by a screw, and steered by means of an apparatus for that purpose, during a flight of nearly thirty miles. If this be so, it must have been probably owing to the serenity of the atmosphere.

During the same year, M. Julien at Paris made a model balloon, shaped like a fish, which was made to move in the air by clock-work operating a pair of wings. The model was four yards long, formed of gold-beater's skin, and filled with gas.

A similar machine on a large scale had been tried in England some twenty years before, and failed, though a model of it had been to a certain degree successful.

Mr. Petin, a countryman of Julien's, projected at the same time (1850) a "system of aërial navigation." Certainly a high-sounding name; but then the machine itself was to be on a large scale. It was to consist of an immense framework 480 feet long, supported by four balloons, each 90 feet in diameter, was to have four parachutes, and a platform for passengers. Two horizontal screws were provided for its propulsion. See BALLOON.

Fly′ing-pin′ion. (*Horology.*) The fly of a clock.

Fly-net. 1. (*Menage.*) A net of meshes, or a fringe of leather strips, to protect a horse from flies.

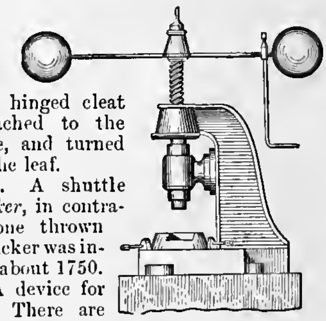
2. A net in an open window to prevent entrance of flies and other insects.

Fly-nut. A nut with wings, to be twisted by the hand; as the screw-nut of a hand-vise.

Fly-press. A screw-press in which the power is derived from a weighted arm, swinging in a horizontal plane, as in embossing and die presses. Presses of this kind are used in making buttons, washers, flat links for chains, cutting and gumming saw-teeth, making percussion-caps, steel-pens, etc.

Fly-punch′ing Press. A press for cutting teeth on saws and for other purposes. The *fly* is the weighted lever, which acquires an impetus in its descent.

Fig 2051.



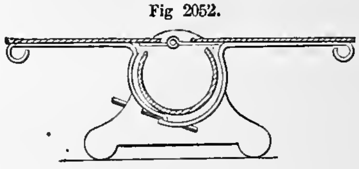
Fly-Punching Press.

Fly-rail. A hinged cleat or bracket attached to the frame of a table, and turned out to support the leaf.

Fly-shut′tle. A shuttle driven by a *picker*, in contradistinction to one thrown by hand. The picker was invented by Kay, about 1750.

Fly-trap. A device for catching flies. There are several forms. In Fig. 2052, the faces of the bait-pans are brought together by spiral springs on the removal

Fig 2052.



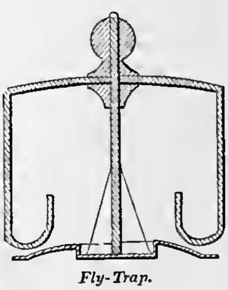
Fly-Trap.

of the detent-pin. On separating the pans for resetting, the flies drop into the receiver beneath.

Another form is that in which the flies unconsciously walk into a *cul-de-sac*, whence they fail to find a way of retreat.

Other forms have rollers baited and turned by clock-work so as to gradually carry the flies around into the gauze trap or to a position from whence they drop into the drowning-tray.

Fig. 2053.



Fly-Trap.

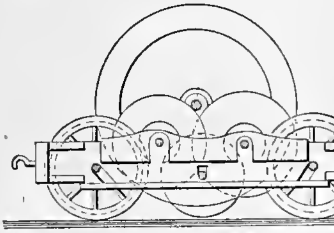
Fly-wheel. A heavy wheel attached to machinery to equalize the movement. By its inertia it oppo.es any sudden acceleration of speed, and by its momentum it prevents sudden diminution of speed; in the latter case it acts as a store of power to continue the movement when the motor temporarily flags, or in passing dead centers when the motor is inoperative.

Fly-wheels were first mounted with teeth on their peripheries, to act as first motions, by Fairbairn of Manchester, England.

The fly-wheel attached to the engine set up at Millwall by Boulton and Watt, for rolling armor-plates, weighs 100 tons.

The *Mahovo* is the name given by the inventor, Captain C. Von Schubersky, of Russia, to an adaptation of the fly-wheel to accumulate a reserve of force to be used at intervals when a greater power is needed.

Fig. 2054.



Von Schubersky's Mahovo.

A pair of heavy cast-steel fly-wheels have an independent truck of their own, which is introduced into the train immediately behind the engine. The truck has three pairs of running-wheels approaching each other very nearly by their circumferences. In the intervals between these wheels are placed two pairs of friction-wheels resting immediately on them; and in the interval between these rests upon their circumferences the large axis of the mahovos; the huge fly-wheels themselves overhanging the truck upon the two opposite sides. When the train moves, the running-wheels impart motion to the friction-wheels, and the latter transfer this movement to the fly-wheels. The diameters of the wheels, and that of the axis of the fly-wheels where it rests upon them, are so related that a velocity of 18.6 miles in the train will generate in the circumference of the fly-wheel a rotary velocity of 466 feet per second; and as the fly-wheels themselves weigh 26 tons, it is computed that, with this velocity, they will embody a living force of 144,000,000 foot-pounds.

As the train moves from rest, the velocity of the fly-wheels is gradually accelerated until it attains a maximum corresponding to the maximum velocity of the train. If steam be now shut off, the fly-wheels become a source of power, and will return the work stored up in them. To stop the train without expending this accumulated force, the friction-wheels are raised out of contact with the driving-wheels. In ascending a grade, the force of the fly-wheels comes in as auxiliary to that of the engine.

Foam-cock. (*Steam-engine.*) A cock at the water-level to blow off scum.

Foam-col-lect′or. (*Steam-boiler.*) A pan or other device at the water-level in the steam-boiler, to catch, retain, and discharge the foam which rises to the surface of the water.

Fo′cal Length. (*Optics.*) The distance between the object-glass and eye-glass of a telescope.

Fo-cim′e-ter. (*Photography.*) An instrument for assisting in focusing an object in or before a camera. This consists usually of a lens of small magnifying power. Formerly, when the fact that the actinic spectrum was mainly outside of the violet end of the spectrum was not properly understood, and lenses were not corrected so as to make the visual and chemical pictures coincident, an instrument was used to determine the amount of movement necessary to throw the actinic picture upon the sensitized plate, subordinating the visual image.

In Claudet's instrument, a number of objects are arranged in a spiral form around the horizontal axis at different distances, so as to be all visible at once from the lens. If, when one of them is in the exact visual focus, another is found to come out more distinctly in the photograph, the discrepancy evidences that the visual and actinic foci do not coincide, and the glass should be rejected.

G. Knight's plan was to place a sheet of negative paper in an inclined position in the camera. A printed sheet being placed before the camera and a picture taken, the relative clearness of the image will determine the true photogenic focus.

Fo′cus-ing-glass. (*Photography.*) A glass used for magnifying the image on the ground glass in the camera, to enable the operator to get it in better focus.

Fog-a-larm′. (*Nautical.*) An audible signal warning vessels from shoals or other dangerous places. Fog-alarms are various in their kind, their operation, and their construction. As to kind, they consist of bells, whistles, and trumpets. As to operation, they are sounded by the current, by the ebbing and flowing tide, by the swaying of the waves, by the wind, by bellows, by clock-work impelled by weight or spring. As to construction, they are adapted for headlands, light-ships, buoys, or to be anchored by piles on spits, sand-bars, or shoals.

A somewhat notable signal of this kind was the bell on the Inchcape Rock, which was placed there by the "good old abbot of Aberbrothock," as sung by Southey in his ballad of "Ralph the Rover." The bell or its clapper was swung by the motion of the waves, and was anchored to the dangerous submerged rock, in the track of navigation in the Frith of Forth. A substantial lighthouse now stands on the rock, which is named from the bell formerly placed on the spot by the courageous, pious monks.

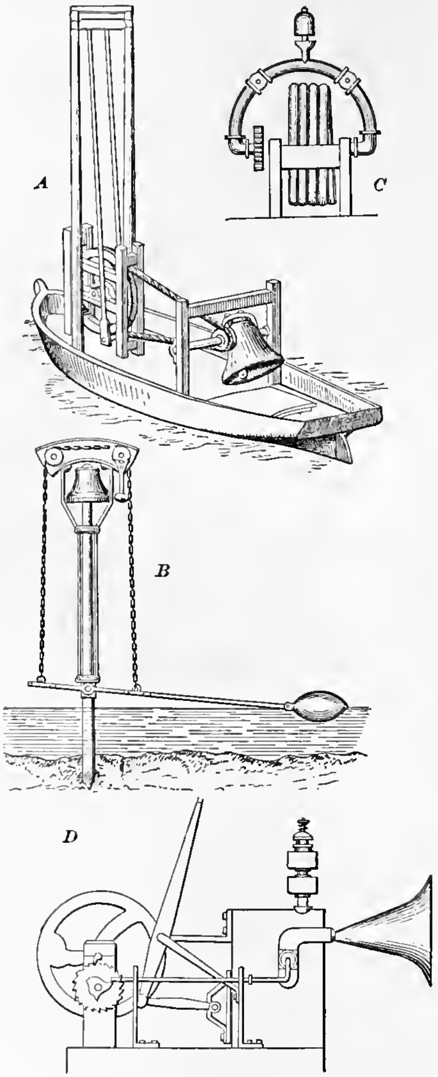
In *A* the apparatus is erected on the deck of a ship which is moored in the position required. From posts on the hull is suspended a pendulous frame which is swung back and forth by the motion of the vessel. A transverse bar in the lower part of the swinging frame actuates the wheel, which is journaled between the pendent arms. Thus the motion of the frame partially rotates the wheel and rings the bell, by means of a band passing over the wheel and over a pulley on the bell-shaft. In *B* the clapper is moved by cam-wheel actuated by chains, which run over pulleys as the float-arm rises and falls by the motion of the waves.

Another form is a bell-buoy with paddles which move the clapper. The clapper of another is moved at regular times by a train of clock-work.

C has a spiral coil of tubing journaled upon standards, and oscillating by the motion of the vessel. Each end of the spiral has a whistle and a valve opening inward. The coil contains a quantity of water, which, as the coil is oscillated, changes its position, and forces the air out through the whistles with a prolonged sound.

In *D* the air is mechanically condensed and stored in a reservoir. The cam on the rotary shaft actuates the valve for the purpose of varying the sounds, to give a series of audible signals more intelligible than mere independent sounds repeated. A trumpet and whistle are attached to connecting pipes proceeding

Fig. 2055.



Fog-Alarms.

from the reservoir. The valve governs the air-aperture in the pipe leading to the trumpet.

Among other devices may be cited: —

One drives compressed air or steam through perforated, rotating disks or plates. The sound-trumpet has a parabolically shaped extension.

Another has cylinders provided with interior clapper-valves near the heads; these admit air when the water recedes, but prevent its escape at the valve-way when the water rises; the air has its exit through the whistles, and sounds the alarm.

Another has two whistles and a single mouth-piece, the aim being to produce discordant sounds, which arrest attention.

A very large fog-whistle, worked by a ten-horse-power engine, is placed on Thatcher's Island, off Salem, Mass.

Fog-bell. A bell upon a vessel, buoy, or spit of land, and rung by the motion of the waves or force of the wind, as a warning to mariners. See FOG-ALARM.

Foge. (*Mining.*) A forge for smelting tin. (Cornwall.)

Fog-horn. See FOG-ALARM.

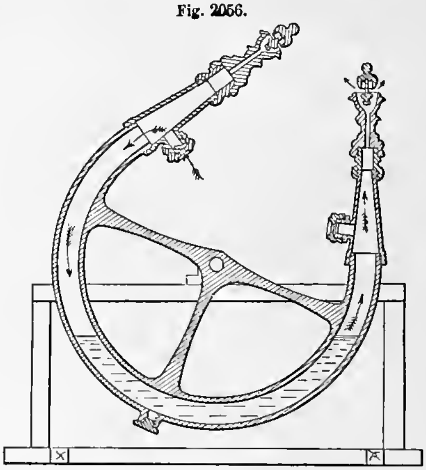
Fog-trump'et. A horn or trumpet placed on a projecting headland, a vessel, or a spar, and blown by mechanical means or by the wind, as a warning to mariners. See FOG-ALARM.

Fog-sig'nal. A detonating ball placed on a railroad track, to indicate danger ahead to the engineer of a passing train.

For nautical, see FOG-ALARM.

Fog-whis'tle. (*Nautical.*) A signal of warning for vessels off a coast. A sounder on the principle of the steam-whistle is exposed to a blast of air or of steam, according to the facilities of operation. Usually, motion derived from the waves, the tide, the wind, or clock-work, make it automatic. In

Fig. 2056.



Fog-Whistle.

the example, the semicircular tubular vessel is mounted upon a rock-shaft, and has at each extremity an ordinary whistle and a valve opening inward. When the vessel is partially filled with water and rocked to and fro, the air is forced through the whistle and sounds an alarm.

On dit: The most powerfuf log-whistle in America is at Cape Fourcher, N. S. It can be heaid fifteen miles in clear weather, and twenty-five with the wind.

Foil. 1. A thin leaf of metal, for plating, or to color a gem behind which it is placed. A colored foil imparts its tint to a gem whose natural color is vague and insipid.

Foil is made by rolling into thin sheets a plate of copper covered with a layer of silver. The silver surface is polished and covered with a clean varnish, colored or white.

Tin or lead foil are very thin sheets.

2. An amalgam of silver and tin at the back of a looking-glass.

3. A blunt weapon for fencing. A thin blade with a button on the end.

4. A leaf in architecture or carving; as a trefoil ornament; or a window, having lobes like clover.

Fold. 1. A fenced-in inclosure for stock.

2. A doubling of fabric; a *plait;* a *hem.*

Fold'ed-an'gle Joint. See ANGLE-JOINT, Fig. 221.

Fold'er. 1. An ivory or bone blade, used in folding sheets for binding; also in forwarding sheets from the pile in feeding to presses.

2. A form of spectacles in which the lenses fold together for the pocket, and grasp the nose by a spring bow or stiff joint when in use.

Fold'ing. The process by which printed sheets are so doubled up as to bring the pages into consecutiveness for gathering and binding.

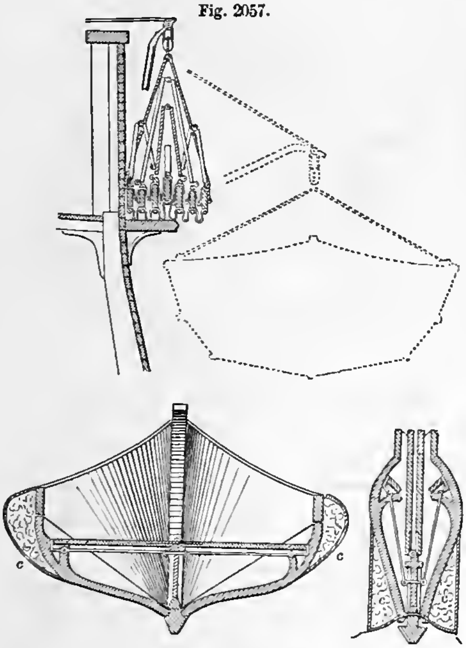
Sheets are of varying sizes, as *demy, medium, royal, imperial,* etc.

The number of pages to each side of the sheet is indicated by the name 4to, 8vo, 12mo, 16mo, 24mo, 32mo, 48mo. The *folio* sheet has two pages on each side and is once folded.

The size of the book will therefore depend upon the size of the paper and the number of times it is folded. Each distinct sheet of a book has a certain mark, called a *signature.* These are *gathered* consecutively to form the book.

Fold'ing-boat. One whose frame is collapsible for compact stowage, either on shipboard or for

Fig. 2057.



Folding-Boats.

transportation on land. In a military point of view, the folding-boat may be used for crossing streams or reconnoitering, or it may be for use as a bridge ponton. Such boats are also used by sportsmen who travel a distance to meet aquatic game, finny or feathered, on coast, lake, or river.

The illustrations show several kinds, and a score more might be readily given would room permit. The upper one is a davit-boat, which lies compactly against the ship's side until the toggle-frame is extended, and the elastic skin distended thereby. It is then swung clear and lowered.

Next are two views, in the extended and collapsed forms respectively, of a boat whose sides are hinged to the keel, and whose stem and stern may be laid over towards the midship section in a similar manner, though this does not appear in the engraving. *c c* are bags of cork which are pendent in the collapsed form, but are caught up against the gunwale when the boat is ready for duty.

The lower figure has a frame which may be folded up to the length of the ribs, and a width equal to the thickness of the ribs when laid up close together. In use, a skin of sufficiently tough waterproof material is stretched over the extended frame. See also LIFE-BOAT.

Fold'ing-chair. A chair which is collapsible for carriage or stowage. One of the examples is a

Fig. 2058.

Folding-Chairs.

library-chair. Another is a camp-chair in two positions. The lower one is in its most prolonged form, and is a lounge.

Fold'ing-door. A pair of doors hung from opposite sides of the aperture, and meeting midway of the passage.

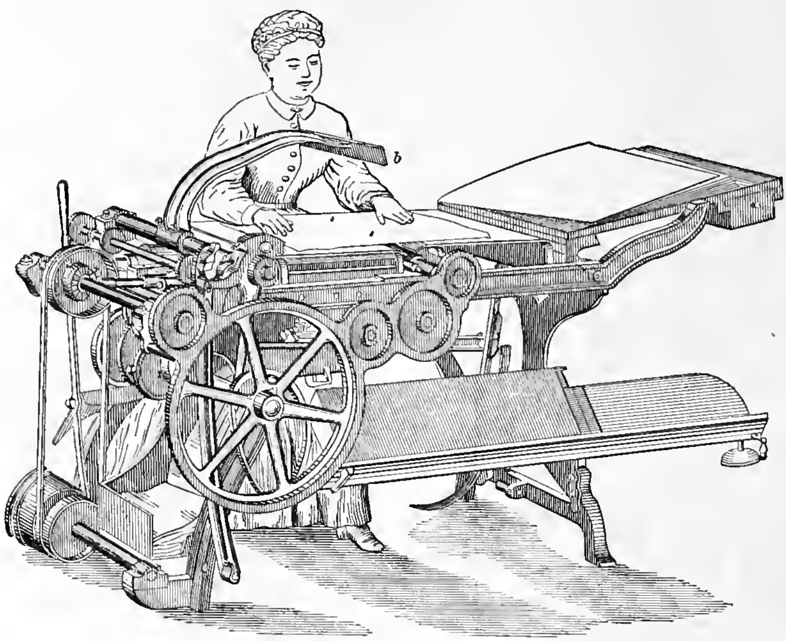
Fold'ing-ma-chine'. 1. A machine for folding printed sheets for books: or newspapers for mailing.

The book-folding machine illustrated is for octavo work, sixteen pages on a sheet, eight pages on a side. The sheet is placed on the table, so that two register-points pass through holes in the sheet previously made on the printing-press. The folder *b* comes down upon the folding edge, the pins give way, and the sheet passes, doubled-edge first, between a pair of rollers which compress it; tapes deliver it to a second table beneath, where a second and a third folder act upon it in turn, and it is delivered into a trough.

With 12mo work, imposed in two parts of sixteen and eight pages respectively, the machine cuts them apart, folds the larger part like an octavo, the smaller folds but once, and is then *inset* into the octavo portion which forms the *outset*.

The two-sheet folder and paster, for large 24-page periodicals, folds one sheet of sixteen pages, $30\frac{1}{2} \times 45\frac{1}{2}$ inches, and another of eight pages, $22\frac{3}{4} \times 30\frac{1}{2}$ inches, insetting the eight pages within the sixteen, and

Fig 2059.

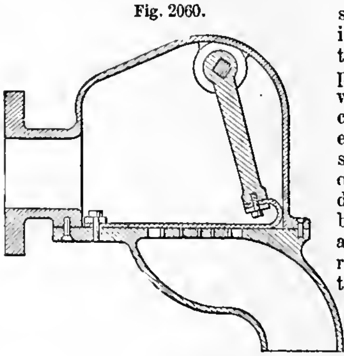


Chambers's 8vo Book-Folding Machine.

pasting and trimming all, delivering a complete copy of twenty-four pages ready to read. It will fold eight pages alone, sixteen pages alone, with or without pasting, or trimming; or will fold, paste, and trim the sixteen pages, and fold, paste, and trim the eight pages, insetting same without pasting in the inset.

Machines of this general character are also made for folding, pasting, and trimming; or for folding, pasting, trimming all round, and putting on a cover of different colored paper. Rev. H. W. Beecher's weekly journal, the "Christian Union," is folded, inset, and covered in this manner. This paper uses a single large sheet of 43 × 47 inches, making twenty-four pages, and, with the added cover, twenty-eight. The sheet is printed on a four-cylinder press, and, by an ingenious arrangement of rollers and tapes, fed mechanically from the impression-cylinders into four folding-machines, an attendant being at each machine to secure accurate pointing. This economy of time in feeding, etc., makes easily possible the printing, folding, pasting, trimming, and mailing (by Dick's system) of nearly 150,000 papers every week, within two and a half working days.

Fig. 2060.



Folding-Valve.

2. (*Metal.*) One which bends pans and tin-ware to form. Some are rollers, others presses, and yet others act like the envelope-machine, having hinged leaves which press up the sides against a former.

Fold'ing-net. A bird-net shutting upon its prey.

Fold'ing-valve. A flexible flap which lies upon the perforated plate forming its seat, and rolls or unrolls thereupon to open or close the passage-way. The band is connected to an arm on a shaft which passes through a stuffing-box to the outside of the case.

Fo'li-at'ed-arch. (*Architecture.*) One having a number of lobes or leaves. See ARCH.

Fo'li-at'ed-joint. (*Carpentry.*) A rabbeted joint, where one part overlies another.

Fo'lio. 1. The running number of the pages of a book. The *even* folios are on the left-hand pages, the *odd* upon the right. The folios of prefatory matter are frequently in lower-case Roman numerals.

2. A book whose sheets are folded but once, four pages to the sheet.

Fo'lio-post. A flat writing-paper, usually 17 × 24 inches.

Fol'low-board. (*Founding.*) A board beneath the pattern, and on which it lies while the loam is being rammed. See FLASK.

Fol'low-er. 1. A portion of a machine, usually sliding in guides, and moved by another portion; as the reciprocating punch-stock in a fly-press, which is moved by the screw to which it is swiveled. It is analogous to the platen of many presses.

2. The cover or *plug* of a stuffing-box, which rests upon and compresses the packing. A *gland*.

Fol'low-er-wheel. The *driven* wheel, as distinguished from the *driver*, or the wheel which impels.

Fon'dus. A style of calico-printing or paper-hanging in which the colors are in bands and blend into each other.

Font; Fount. (*Printing.*) An assortment of type of one size, of a given weight, containing large and small capitals, small letters, points, accents, figures, spaces, quads, etc. The weights of fonts vary according to the business requirements of the printer. While a 500-pound book-font was considered a good weight during the last century, some American houses now keep a font of from 20,000 to 30,000 pounds in use.

The following table gives an English bill of Pica, weight 800 pounds, italic one tenth.

a,	8,500	í,	100	!	150	P,	400	I,	400
b,	1,600	ó,	100	'	700	Q,	180	J,	150
c,	3,000	ú,	100	*	100	R,	400	K,	150
d,	4,400	à,	200	†	100	S,	500	L,	250
e,	12,000	è,	100	‡	100	T,	650	M,	200
f,	2,500	ì,	100	[	150	U,	300	N,	200
g,	1,700	ò,	100	‖	100	V,	300	O,	200
h,	6,400	ù,	100	§	100	W,	400	P,	200
i,	8,000	â,	200	(	300	X,	180	Q,	90
j,	400	ê,	200	¶	60	Y,	300	R,	200
k,	800	î,	100	1,	1,300	Z,	80	S,	250
l,	4,000	ô,	100	2,	1,200	Æ,	40	T,	320
m,	3,000	û,	100	3,	1,100	Œ,	30	U,	150
n,	8,000	ä,	100	4,	1,000	A,	300	V,	150
o,	8,000	ë,	100	5,	1,000	B,	200	W,	200
p,	1,700	ï,	100	6,	1,000	C,	250	X,	90
q,	300	ö,	100	7,	1,000	D,	250	Y,	150
r,	6,200	ü,	100	8,	1,000	E,	300	Z,	40
s,	8,000	ā,	100	9,	1,000	F,	200	Æ,	20
t,	9,000	ē,	150	0,	1,300	G,	200	Œ,	15
u,	3,400	ī,	100	$	100	H,	200		
v,	1,200	ō,	100	A,	600				
w,	2,000	ū,	100	B,	400				
x,	400	ă	100	C,	500				
y,	2,000	ĕ	150	D,	500				
z,	200	ĭ	100	E,	600				
&,	200	ŏ	100	F,	400				
fi,	500	ŭ	100	G,	400				
ff,	400	ç,	100	H,	400				
fl,	200	ñ	100	I,	800				
ffl,	100	,	4,500	J,	300				
ffi,	150	;	800	K,	300				
æ,	100	:	600	L,	500				
œ,	60	.	2,000	M,	400				
á,	100	-	1,000	N,	400				
é,	250	?	200	O,	400				

Spaces.

Thick .	18,000
Middle .	12,000
Thin . .	8,000
Hair .	3,000
Em-quadrats	2,500
En-quadrats	5,000

Large Quadrats.

2-em, 3-em, 4-em } 80 pounds.

Metal Rules.

1-em, 2-em, 3-em.

For indexes and similar matter, the above would be deficient in capitals.

For setting up French or Italian matter, it would be deficient in accented vowels.

It comprises, —

Capitals ; as, A, B, etc.

Small capitals ; as, A, B. etc.

Lower case ; as a, b, etc.

Figures and fractions ; as, 1, 2, 3 ; $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{20}$, etc.

Points, —, ; : . ? ! - ' ( ) [ ] * † ‡ § ‖ ¶ — ⁓

Spaces. Quads.

Accents ; as, á, à, â, ä, ā, ă.

The above bill does not include, —

Superior letters in caps or lower case ; as, A^{A}, B^{D}, etc. ; A^{a}, B^{a}, C^{d}, etc. ; a^{A}, b^{C}, etc. ; c^{a}, d^{b}, h^{d}, etc.

Inferior letters in caps or lower case ; as, A_{C}, C_{B}, etc. ; A_{a}, B_{a}, B_{b}, etc. ; a_{B}, c_{E}, etc. ; a_{a}, b_{a}, c_{b}, etc.

Superior figures in Arabic or Roman ; as B^{1}, C^{2}, D^{3}, etc. ; a^{i}, b^{ii}, c^{vi}, etc.

Inferior figures in Arabic or Roman; as, A_{1}, B_{2}, C_{3}, etc. ; a_{i}, b_{iv}, c_{v}, etc.

Prime letters ; A′, B″, C‴; a′, b″, c‴, etc.

Arithmetical signs ; such as +, ×, −, ÷, :, ::, =, √.

Notation of arc : °(degrees), ′(minutes), ″(seconds).

Of quantity : ℔. ℥, ʒ, ℈, ♏.

Commercial : $, c, ℔, %, @, a/c, £.

Besides these, there are hundreds of arbitrary signs, which are found in the most perfect fonts, and used in astronomical, classic, commercial, musical, chemical, botanical, arithmetical, and mathematical dissertations.

For these, see an excellent digest on pp. 1692–96 of Webster's Unabridged Dictionary, edition of 1867.

Almost every science has symbols of its own. Algebra has one set, chemistry another. For a dictionary which attempts to represent the minute shades of pronunciation a great number are required. Thus in Webster or Worcester, what with letters with dots above and dots below, lines above, below, and across, there are probably a hundred additional characters. Some foreign languages have a very complicated alphabet. The Greek, with its "accents" and "breathings," requires about 200. Formerly there were so many logotypes and abbreviations as to require 750 sorts. The Oriental alphabets are complex. The Hebrew, with the Masoretic points, requires about 300 sorts, many differing only by a point, stroke, or angle. The Arabic has quite as many. In Robinson's Hebrew Lexicon, eight or ten Oriental languages appear, and required 3,000 sorts distributed through at least forty cases.

Fools'cap. A size of folded writing-paper named from the water-mark of a "foolscap and bell" which formerly ornamented (?) it.

In England, it has four grades of size and weight.

		Size.		Weight.	
Sheet and a half foolscap,		$25\frac{1}{2} \times 13\frac{1}{4}$	inch.	22	pounds.
Sheet and third	"	$22 \times 13\frac{1}{4}$	"	20	"
Extra thick	"	$16\frac{1}{2} \times 13\frac{1}{4}$	"	18	"
Ordinary	"	$16\frac{1}{2} \times 13\frac{1}{4}$	"	15	"

The American average may be stated at $16 \times 12\frac{1}{2}$.

Foot. 1. (*Music.*) The lower end of an organ-pipe, which conducts the wind to the *reed* or *lip*, which gives the vibration to the air and causes the sound.

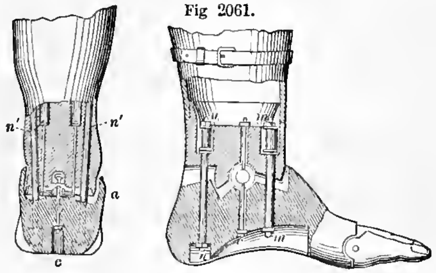
2. (*Nautical.*) The lower edge of a sail.

3. (*Machine.*) A flange at the lower end of a leg to give a wider basis of support.

4. A third of a yard. See UNIT.

Foot, Ar'ti-fi'cial. A prosthetic contrivance which copies the articulations of the natural foot. In the best efforts in this line, the ankle-joint is a

Fig 2061.



Artificial Foot.

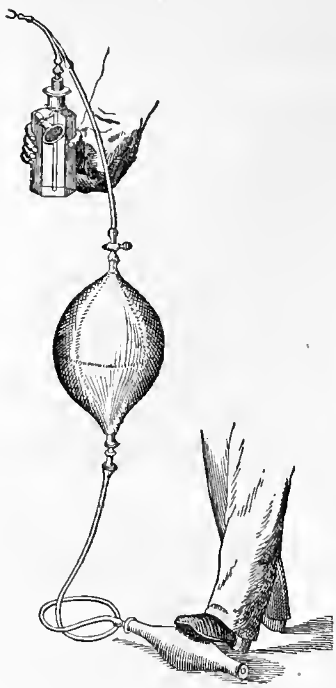
bolt which is transverse with the foot, a certain degree of lateral flexure in a vertical plane being also permitted, as seen by the interval shown in the left-hand figure opposite to *a*. The other figure also shows a certain liberty of forward and backward rocking motion. The middle rod *c* is a permanent tension-rod, and the rods *m n n′* have a certain amount of elasticity by means of rubber nuts, so as to allow flexure of the joint.

Foot-bel'lows. A form of bellows with a collapsible bag, or an ordinary bellows arranged to be worked by treadle. It is shown (Fig. 2062) as adapted to a spray apparatus.

Foot-board. 1. A treadle.

2. A board at the foot of a bed ; a board for the feet on the driving-box of a coach.

Fig. 2062.



Foot-Bellows

3. The platform on which the driver and stoker of a locomotive stand. A *foot-plate.*

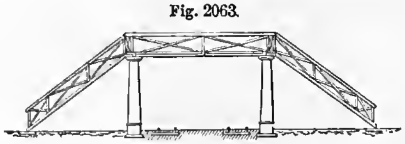
Foot-bridge. 1. One for pedestrians over a railway or crowded city thoroughfare.

2. (*Machinery.*) A curved bar supporting the *foot* or *toe* of a mill spindle. See STEP.

Foot-guard. (*Menage.*) A boot or pad to prevent the cutting of the feet by interfering or overreaching. See LEG AND FOOT GUARD.

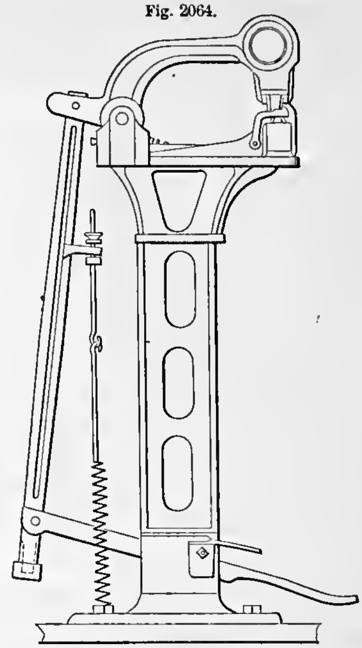
Foot-ham'mer. One worked by a treadle. The hammer is adjustably pivoted to the upright, and has toggle connection with the treadle, whose depression causes the descent of the hammer upon the anvil. The hammer is raised by a spring.

Fig. 2063.



Foot-Bridge.

Fig. 2064.



Foot-Hammer.

Foot-pace. A *dais*, or raised floor.

Foot-pad. (*Menage.*) *a.* A piece of elastic substance, say rubber, to cover the sole of a horse's foot and prevent balling.

b. An anklet or ridge-piece on the corona to prevent cutting of one foot by the other in traveling.

Foot-plate. The platform for the driver and fireman of a locomotive.

Foot'ing. 1. (*Hydraulic Engineering.*) The lower portion of the slope of a sea embankment. It should have a base of five feet to one foot perpendicular and be protected by gravel. The portion above the footing is the *outburst bank*, and has a base of two to one perpendicular. The crowning portion is the *swash-bank*, which has a base of two to one perpendicular, the level on top being four or five feet. In Holland, where the summit is used for roads, this width is much increased.

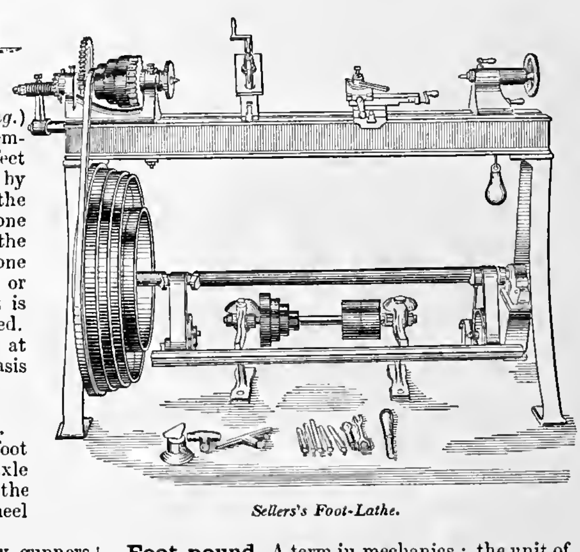
2. (*Masonry.*) The spreading courses at the bottom of a wall, to give a greater basis of support.

Foot-i'ron. A carriage-step.

Foot-key. (*Music.*) An organ pedal.

Foot-lathe. A lathe driven by the foot on a treadle, connected to a crank on an axle beneath the bench. A driving-wheel on the axle is connected by a band to a cone-wheel on the mandrel of the head-stock.

Fig. 2065.



Sellers's Foot-Lathe.

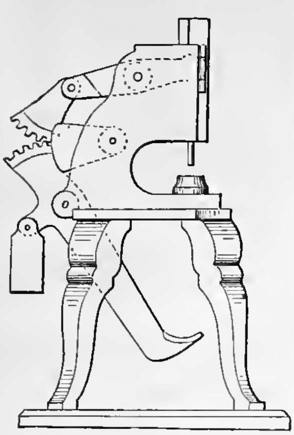
Foot-lev'el. A form of level used by gunners in giving any proposed angle of elevation to a piece of ordnance. See LEVEL.

Foot-light. A light on the front of a stage.

Foot-pound. A term in mechanics; the unit of energy, 1 pound avoirdupois raised 1 foot. See UNIT.

Foot-press. A form of standing press in which the upper die or follower is depressed by a treadle.

Fig. 2066.



Foot-Press.

In the example, the motion is obtained by the mashing of two segmental cam-gears forming a toggle.

Foot-rail. A railroad-rail having wide-spreading foot flanges, a vertical web, and a bulb-shaped head. Such a rail may be spiked to the sleepers, dispensing with chairs.

Foot-rest. (*Menage.*) A stake in a shoeing shop on which a horse's foot is rested to relieve the shoer from the labor of supporting it.

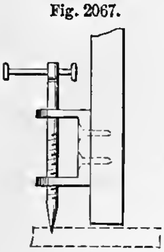
Foot-rope. (*Nautical.*) *a.* A rope stretched beneath a yard, upon which the seamen stand in reefing or furling sails.

b. A rope at the foot of a rail.

Foots. Sedimentary matter; the remainder or refuse of decantation or distillation.

Foot-screw. A supporting foot, for giving a machine or table a level standing on an uneven floor.

Fig. 2067.



Foot-Screw.

Foot-stalk. (*Machinery.*) The lower portion of a mill spindle; it rests in a *step.*

Foot-stall. 1. (*Architecture.*) The plinth or base of a pillar.

2. (*Menage.*) The stirrup of a woman's saddle.

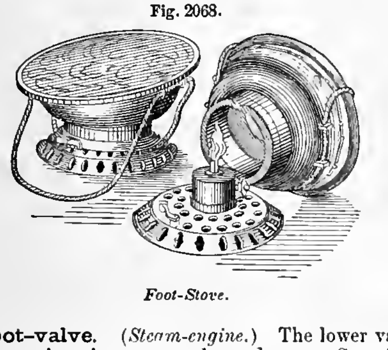
Foot-step. An inclined plane under a hand printing-press.

Foot-stick. (*Printing.*) A wedge-shaped piece of furniture placed against the foot of the page. The *quoins* are driven in between the *foot-stick* and the *chase* in locking up the *form.*

Foot'stool. A low stool for the feet.

Foot-stove. A foot-warmer; usually heated by a lamp.

Fig. 2068.



Foot-Stove.

Foot-valve. (*Steam-engine.*) The lower valve between the air-pump and condenser. See AIR-PUMP, p. 53.

Foot-vise. A vise whose jaws are brought together by means of a strap passing through the two and operated by a treadle. It has not a very powerful grasp, but from the facility with which the jaws are opened or closed is useful in operating on objects which do not require to be held very firmly.

Foot-wal'ing. (*Shipbuilding.*) The inner *skin* of a ship between the *deck-beams* and the *limber-strakes* on each side of the *keelson.* Also called the *ceiling.*

Foot-warm'er. A heated stool for the feet. A chafing-dish. A *foot-stove.*

A hot-water bottle shaped to fit against the soles of the feet of a person lying in bed.

For'ceps. A tool applied to grasping, and consisting of two portions pivoted together, the ends forming respectively handles and jaws.

Shears, scissors, pincers, pliers, tongs, calipers, nippers, punches, and some other tools, agree in the pivoting of duplex parts, but they differ in some peculiarity of the jaws or in their special application for cutting or grasping. See JAW-TOOLS.

Forceps for teeth, uvula, arteries, esophagus, etc., were found in a house in Pompeii in 1819. They were of iron and copper.

Specifically: in obstetrics, an instrument having a pair of curved blades for grasping the head of the fetus and assisting delivery.

See under the following heads: —

Alveolar forceps.
Artery-forceps.
Bone-forceps.
Bullet-forceps.
Calculi-forceps.
Cow-horn forceps.
Crane's-bill.
Craniotomy-forceps.
Crow's-bill.
Dental forceps.
Dissecting-forceps.
Esophagus-forceps.
Eye-forceps.
Fulcrum-forceps.
Locking-forceps.
Needle-forceps.
Obstetrical-forceps.
Placenta-forceps.
Plugging-forceps.
Polypus-forceps.
Screw-forceps.
Speculum-forceps.
Spicula-forceps.
Stage-forceps.
Strabismus-forceps.
Trachea-forceps.
Uvula-forceps.

Force-pump. 1. A pump which delivers the water under pressure, so as to eject it forcibly or deliver it at an elevation. The term is used in contradistinction to a *lift-pump,* in which the water is lifted, and simply *runs* out of the spout.

The *single-acting* force-pump is that in which the *lift* and *delivery* are alternate. The *double-acting* is that in which the passages are duplicated, so that a *lift* and *delivery* are obtained by each motion of the plunger: the pump has a distinct water-way both above and below the piston, so as both to draw and force water at each stroke, and thus cause a continuous stream, which is rendered more uniform by an air-chamber.

The invention of the force-pump is ascribed to Ctesibus of Alexandria, who is assumed to have been the tutor of Hero, who wrote so largely on hydraulics. It was also described by Vitruvius.

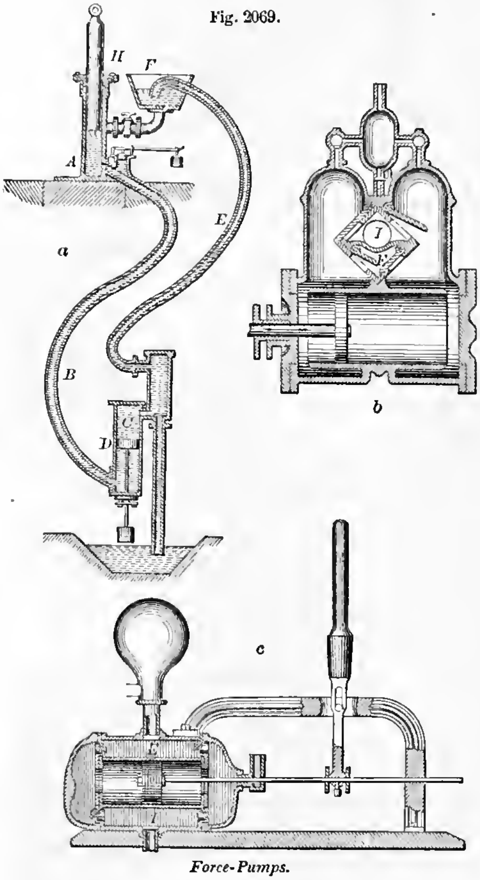
In 1582, Peter Morice, a Dutchman, erected a pumping-engine at London Bridge, where it or its successors remained till 1821. The power was a current-wheel turned by the flow and ebb, and first placed *near* the bridge, then *under* the northern arch; afterwards three wheels were added under the third arch; Smeaton added another under the fifth arch, and afterwards a steam-engine to assist at low-water and neap tides. See CURRENT-WHEEL.

The water-wheel of Morice worked sixteen force-pumps, each seven inches in diameter, the pistons having a stroke of thirty inches, throwing 216 gallons per minute into a cistern elevated 120 feet, whence the dwellings in the vicinity were supplied with water by leaden pipes.

In 1731 the works are again described. Sixty-eight pumps were then at work, throwing 2,052 gallons per minute. The cylinders were of cast-iron, 4 feet 9 inches long, 7 inches bore, and discharged by a stand-pipe into a cistern elevated 120 feet.

The Verpilleux pump (*a*) is a single-acting force-pump in which a column of water communicates between the working cylinder and the water level. When the plunger *H* rises, water ascends and passes through *C* into *B* and upward into *A*; owing to the pressure of air upon the surface of the water in the cistern, supplemented for hights above, say 30 feet, by the weight of the loaded piston *D*. When the

Fig. 2069.



Force-Pumps.

plunger *H* descends, the column of water in *B* acts upon the piston *D*, and raises water in *E* to the reception cistern *F* above.

b c are two forms of double-acting force-pumps, in each of which *I* is the induction and *E* the eduction.

2. The boiler-supply pump connected to the piston-rod of the cylinder of a locomotive.

For'cer. A small pump worked by hand; used in sinking pits, draining cellars, etc.

Forc'ing-pit. A sunken hot-bed.

Fore. (*Nautical.*) The term expressive of the forward portion of a vessel, or the appurtenances of the said forward portion. The term is used in contradistinction to *aft*.

Fore-and-aft Sail. (*Nautical.*) A sail whose middle position is fore-and-aft; one which is attached to a spar or stay in the midship line of the vessel, and not to a yard, which is athwart ship.

It may be three-cornered, as a *stay-sail* or *jib*, or four-cornered, as a *try-sail*, *spanker*, etc.

Of the latter, —

The upper, after corner is the *peak*.

The upper, forward corner, the *throat* or *neck*.

The lower, after corner, the *clew*.

The lower, forward corner, the *tack*.

The *clew* is hauled aft by a rope called the *sheet*.

The *tack* is hauled forward by a rope also called the *tack*.

In a fore-and-aft sail,—

The *head* is the upper edge if the sail be four-cornered, or the upper corner if the sail be three-cornered.

The *foot* is the lower edge.

The foremost edge is called the *luff* or *weather-leech*.

The aftermost edge is called the *lee-leech*, or the *leech*.

Schooners, smacks, and cutters are fore-and-aft rigged. The *spankers*, *drivers*, *jibs*, *try-sails*, and *stay-sails* of other vessels are also fore-and-aft.

Fore-bay. (*Hydraulics.*) A reservoir or conductor between a mill-race and a water-wheel. The discharging-end of a head or mill-race. The term is the equivalent of *penchute* or *penstock*, but is used especially in regard to water-wheels, which receive and discharge water at their peripheries, such as the under-shot, over-shot, breast, and flutter-wheels.

Fore-beam. (*Weaving.*) The breast-beam of a loom.

Fore-bow. (*Menage.*) The pommel or horn of a saddle.

Fore-car'riage. (*Vehicle.*) The forward part of the running gear of a four-wheeled vehicle. The fore-wheels, axle, and hounds; with or without the *pole* and the *perch*.

Fore'cas-tle. (*Shipbuilding.*) *a.* In flush-decks; a part of the upper deck forward of the after fore-shroud.

b. A short upper deck forward. Formerly raised like a castle to command the enemy's decks. A top-gallant forecastle.

c. A forward part of the space below decks in merchant-ships, for the seamen.

Fore-edge. The front edge of a book or a folded sheet; in contradistinction to the *back*, which is folded, and holds the stitching.

Fore-foot. (*Shipbuilding.*) The forward end of a vessel's keel on which the stem-post is stepped.

Fore-gang'er. (*Nautical.*) A short rope grafted on to the harpoon, and to which the rope is bent.

Fore-ham'mer. A sledge-hammer, working alternately or in time with the hand-hammer.

Fore-hook. (*Shipbuilding.*) A strengthening piece in the stem, binding the bows together. A *breast-hook*.

Fo'rel. (*Bookbinding.*) A kind of parchment for book-covers.

Fore'land. 1. (*Hydraulic Engineering.*) That portion of the natural shore on the outside of the embankment which, standing several feet above low-water mark, and having a considerable breadth, acts as an advanced guard to the embankment to receive the shock of the waves and deaden their force upon the bank.

2. (*Fortification.*) A space between a fortified wall and the moat.

Fore-lock. A cutter or split pin in the slot of a bolt to prevent retraction. A *linch-pin*. A *pin* fastening the cap-square of a gun. A *key*.

Fore-lock Bolt. One retained by a *key*, *gib*, or *cotter* passing through a slot of the shank. See KEY; COTTER.

Fore-lock Hook. (*Rope-making.*) A winch or *whirl* in the *tackle-block* by which a bunch of three yarns is twisted into a *strand.*

Fore'mast. (*Nautical.*) The one nearest to the bow, in vessels carrying more than one mast, except in the case of a *ketch,* whose forward mast is the *main,* as being the longer of the two, the after-mast being the mizzen.

Fore-part I'ron. An edge rubber or burnisher for boot and shoe soles.

Fore-piece. (*Saddlery.*) The flap attached to the fore-part of a side-saddle, to guard the rider's dress.

Fore-plane. (*Joinery.*) Intermediate in length and application between a *jack*-plane and a *smoothing*-plane.

Fore-rake. (*Shipbuilding.*) So much of the forward part of a vessel as overhangs the keel.

Fore-run'ner. (*Nautical.*) A piece of red bunting on a log-line at a certain distance, say twelve or fifteen fathoms, from the log-chip; the fathoms begin to count at the fore-runner, and the non-counting portion is called the *stray-line.* The latter is an allowance to allow the log to be out of the ship's dead-water. See LOG.

Fore-shore. (*Hydraulic Engineering.*) *a.* A bank a little distance from a sea-wall to break the force of the surf.

b. The seaward projecting, slightly inclined portion of a breakwater.

Fore-shot. The first portion that comes over in distillation of low wines. It is a milky liquid and abounds in fusel oil.

Fore-sight. 1. A sight *forward* at the leveling-staff or through the sights of the circumferentor.

2. The muzzle-sight of a gun.

Fore-staff. (*Optics.*) An instrument formerly used at sea for taking the altitude of heavenly bodies, and also known as a *cross-staff.* The observer faces the object, the position being the reverse of that assumed in using the *back-staff* for a similar purpose. The fore-staff has a straight, square staff graduated like a line of tangents, and four *crosses* or vanes which slide thereon. The first and shortest of these vanes is called the *ten*-cross, and belongs to that side of the instrument whereon the divisions begin at 3° and end at 10°. The next longer vane, called the *thirty*-cross, belongs to the side of the staff graduated from 10° to 30°. The *sixty*-cross belongs to the side graduated from 20° to 60°. The *ninety*-cross belongs to the side of the staff graduated from 30° to 90°.

Fore-star'ling. An ice-breaker in advance of the *starling* of a bridge.

Fore-wale. (*Saddlery.*) The smaller roll of a horse-collar.

Forge. 1. A blacksmith's open fire, where iron is heated by the aid of a blast. The illustration shows a portable form, in which the bellows is worked by a treadle, the air-pipe passing upward and through a tuyere into the coal-box *a,* which is shown empty. *b* is the slake-trough.

2. A building in which blacksmith's forges or furnaces are arranged. When on a large scale, furnaces, cranes, and steam-hammers are necessary adjuncts. A *smithy.*

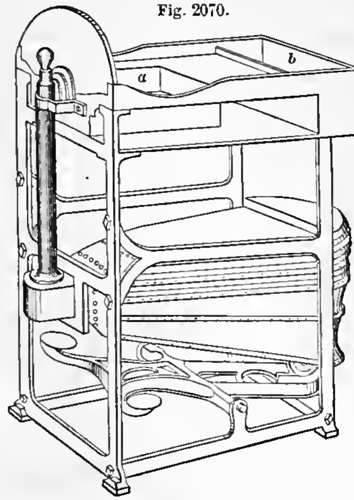
3. A place where iron is puddled and shingled.

4. A field-forge in military service. See BATTERY-FORGE.

The subject of *forging* is incidentally considered under CANNON, ARMOR-PLATING, and elsewhere, and the appliances under ANVIL, HAMMER, etc. See HAMMER; also list under BLACKSMITH'S TOOLS, etc.

Considering how lately it has been deemed possible to forge very large masses of iron, and how all

Fig. 2070.



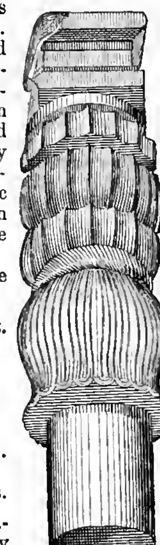
Portable Forge.

the best modern appliances of furnaces, cranes, and steam-hammers are engaged in the production of heavy cannon, screw and paddle shafts of steamships, anchors, etc., we may well be surprised at the existence within the cincture of the ancient Mosque of the Kutub, near Delhi, of a wrought-iron pillar of a size which would be deemed a first-class forging in the most capable works of Europe or America. The pillar is, however, more than 1,000 years old, and may be as much as 1,500. It is believed that the ornamental capital was chipped from the solid. Digging has shown that the greater portion of the length is buried in the ground. It has about midlength an inscription in Sanscrit, in a character which has been assigned to the period A. D. 300 to 400. It has been described at length by Mallet in the "Engineer." The present writer concludes that it is a casting from iron smelted by a process allied to the Catalan, — the ordinary smelting process of Asia and Africa, in fact, — from a magnetic or hematite ore by charcoal. Such an iron may be worked to some extent by the hammer.

The iron pillar of Delhi has the following dimensions: —

Hight above ground .	22 feet.
Depth beneath ground, so far as is known by digging	26 "
Estimated hight . . .	60 "
Hight of capital . . .	3½ "
Upper diameter of shaft	12.05 inch.
Lower diameter of shaft	16.4 "
Weight (calculated) .	38,080 lbs.

Fig. 2071.



Iron Pillar of Delhi.

Forge-rolls. The name conferred upon the train of rolls by which the slab or bloom is converted into puddled bars.

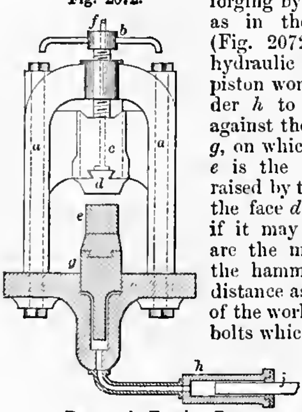
They consist of two pairs, the *roughing-down* rolls and *finishing* rolls.

For'gette. (*Glove-making.*) Fr., *fourgette.* The piece put between the fingers of a glove, and to which the front and back parts of the fingers are sewed.

Forg'ing-ham'mer. A hammer used by gold-beaters. It weighs three pounds, has a head at one end and a wedge at the other, the face having a square area of 1½ inches on the side. Its handle is 6 inches long. It is the first hammer in the series, and reduces the ingot of gold to one sixth of an inch. The anvil is a mass of steel four inches long and three broad. The *laminating-machine* is often used instead of the *forging-hammer.*

Forg'ing-ma-chine'. A machine having a number of plunging mandrels and stakes between which a heated bar is pressed to form. The opposing faces of the plungers and stakes may be merely hammer-faced, or may be shaped to act as swages.

Fig. 2072.



Bessemer's Forging-Press.

Forg'ing-press. One for forging by means of pressure, as in the Bessemer press (Fig. 2072), which acts by hydraulic pressure. *j* is a piston working in the cylinder *h* to drive the water against the base of the piston *g*, on which is the anvil face. *e* is the forging which is raised by the piston *g* against the face *d* of the hammer *c*, if it may be so called; *f b* are the means for lowering the hammer *c d* to such a distance as may suit the size of the work. *a a* are through-bolts which sustain the pressure.

Fork. An implement with prongs for lifting, digging, carrying, or throwing. Its uses may be principally included under the heads of *agricultural* and *husbandry* uses and *domestic* uses.

Of the former are: —

Dung or *manure* forks.
Horse hay-forks.
Digging-forks.
Grain-forks.
Hay-forks.
Pitch-forks.

Of the domestic are: —

Culinary or *flesh* forks. *Table*-forks.

1. The fork of the husbandman is shown on the Egyptian tombs, and referred to in the Book of Judges, 1093 B. C.: "Yet they had a file for the mattocks, and for the colters, and for the forks."

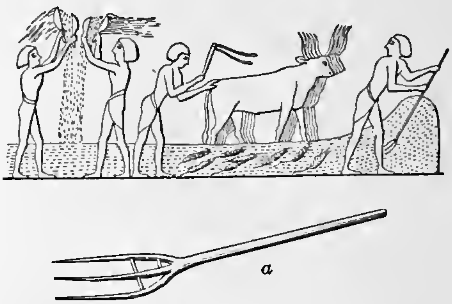
The pitch-fork is used for grain in the straw or sheaf, hay, and manure. It has from two to four teeth, according to its purpose. The four-pronged is used for manure, the others for straw, sheaves, or hay.

Another form of grain-fork (*a*) is of wood, the operative end being slit into three prongs, which are held apart by wedges and braced by rods.

It is used in delivering the gavel of grain from the platform of the reaping-machine, and is preferred for the reason that its tines do not injure the platform, or offer so much danger to the person or the machine as do sharp iron tines.

In the scenes where the thrashing of grain is represented on the tombs of Egypt, we see several instances of the three-pronged fork. It appears to be of wood, the end split into three tines, which are held apart in some way, perhaps, as with us, by wedges.

Fig. 2073.



Grain-Fork (Thebes).

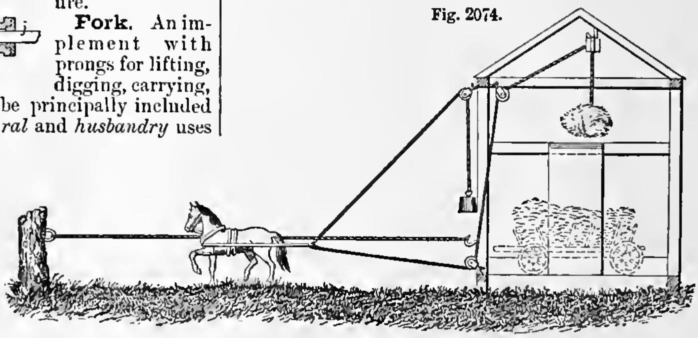
The digging-fork has four flat steel tines, and is a very effective tool.

The pitch-fork has two or three long, round tines, and is used for pitching hay or sheaves. The barley-fork is a peculiar fork having a guard on the head, and used for pitching gavels of short grain without binding.

The horse hay-fork is designed to obviate the great labor of pitching hay from the wagon into the mow, or from the wagon or the ground into the stack. They are of four kinds: —

1. The *harpoon*-fork.
2. The *jointed*-fork.

Fig. 2074.



Operating Horse Hay-Forks.

3. The *tongs*-fork.
4. The *corkscrew*-fork.

Fig. 2074 gives a general idea of the mode of operating the fork. A rope passes from the single-tree of the horse over three pulleys to the fork, which is thrust into the load. When the horse starts up, the load is lifted, and when it has reached the desired hight a trigger is pulled and the load dropped. The horse is backed, allowing the fork to descend, assisted by the weight which takes up the slack of the fall.

1. The *harpoon-fork* is thrust endwise into the hay, the tines being sheathed; then, by the motion of a lever, the tine or tines are exposed so as to catch the hay and elevate it when the fork is lifted. On reaching the place where the forkful is to be deposited, the catch which holds the tines in their ex-

tended position is dropped by drawing on a trigger; the tines becoming sheathed by the pressure upon them of the hay, the latter slips off. Two forms of this are shown, but twenty-eight are before the writer while making this notice. Fig. 2075 has a tube from which protrude two prongs *F F*, which are thrust out into the hay after the stem has been driven in to the required depth. When lifted, the load rests on the prongs, and when a trigger on the stem is pulled by the cord *g*, the prongs retreat; the tube falls until it catches on the cross-piece of the stem *D*. In Fig. 2076 the parts *E* and *F* form the entering portion and maintain a general longitudinal direction while the fork is thrust into the hay, and are vibrated outwardly to hold the hay by the pivoted rod, which is actuated by a lever and auxiliary rope, to drop the load when it has arrived over the desired spot.

2. The *single-jointed* fork is one in which the tines are hinged to the stock, so as to assume a position in which the hay will be sustained, but capable of being dropped from this position so as to allow the hay to slip off. The *modus operandi* is this:

Fig. 2075.

Fig 2076.

Harpoon-Forks.

The tines of the fork in its effective position are thrust into the hay, and the fork with its load is then elevated. On reaching the place where the load is to be deposited, a trigger is pulled, releasing the tines; the weight of the hay causes them to drop, and the load slips off.

Of fifteen kinds at hand, two may be selected as representative. In Fig. 2077, the tines are on a head attached to the stock *C* and hinged to the bail *D*. *F* is a hinged brace, which thrusts against a stud in a slot of the stock *C*, to hold the tines in their holding position. The tines are tripped by the rope and trigger *i*, which pushes the brace *F* off the detent and allows the head and stock to rotate on the bail.

Fig. 2078 has its tines *a* hinged at midlength, and tripped by lifting the trigger *e* on the end of the rope *f*.

Fig. 2077

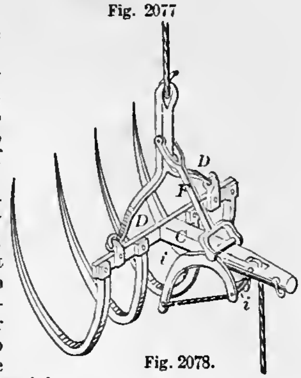


Fig. 2078.

Jointed Forks.

3. The *tongs*, or *grabbing-fork*, has two hands, so to speak, which clasp upon the bunch of hay, and are locked in their closed position while the hay is being lifted. When arrived at the place to drop the hay, a rope attached to a trigger is pulled, the two heads of the fork are unlocked, and the weight of the hay presses them open, the hay falling out. The two forms shown are held closed by a straight toggle, and opened when the toggle is bent by a pull on the rope. In Fig. 2079 the fork is swung from one prong, and in Fig. 2080 from both prongs.

4. The *corkscrew-fork* is screwed down into the hay, turning in its handle or stock; a latch holds it in position while the hay is lifted. A trigger then releases the catch, and the tine being freed is rotated by the weight of the hay which slips therefrom.

Fig. 2079.

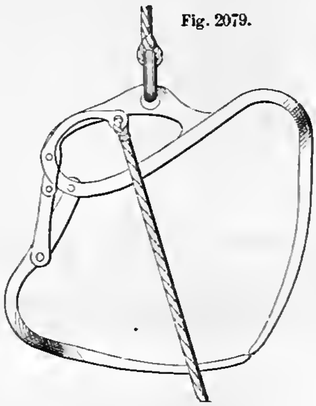
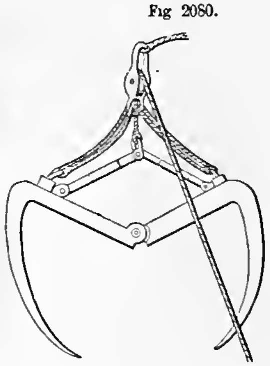


Fig 2080.



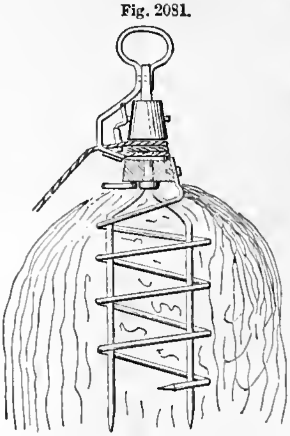
Tongs-Forks.

As the vertical tines descend into the bunch of hay, the spiral tines are rotated and then locked. The load being elevated, the cord is pulled, disengaging the detent and revolving the spiral tines to discharge the load.

2. Forks for culinary purposes were common in ancient times, *vide* the observances of the Hebrew priests, who dipped their forks into the seething-pot and lifted the meat thence. The table-fork is a modern invention, deriving its name from the Italian *forca*.

The Greeks and Romans had also flesh-forks or rakes to lift meat from the pot, but they had no table-forks. The carver, *carptor*, had a knife for carving, and the guests furnished their own. The meat was grasped by the finger and thumb of the

Fig. 2081.



Corkscrew Hay-Fork.

left hand, and a piece excised. The New Testament, Homer, and Ovid mention the putting of the hands in the dish.

The "dipping in the dish" refers to making a scoop of a piece of bread and dipping out the soup or gravy. To give a "sop" thus prepared to a friend at table was a delicate attention. Judas received his and "went out." The mark of kindness was too much even for his selfish heart.

The Chinese use chop-sticks instead of forks.

Bronze forks were used by the Egyptian priests in presenting offerings to the gods. Two of them exhumed at Sakkarah are in the Abbott collection.

A fork is mentioned in the accounts of Edward I., and is supposed to have been brought from the East by a returning crusader. Voltaire says that they were used by the Lombards in the fourteenth century; and Martius states that they were common in Italy in the fifteenth century.

Table-forks are heard of in Italy from 1458 to 1490. An Italian at the court of Matthias Corvinas, king of Hungary, notices the lack of the fork in the table furniture of the king. A century after, they were not known in France or Sweden.

Coryat, in his "Crudities," 1611, says: "I observed a custom in all those Italian cities and towns through which I passed, that is not vsed in any other country that I saw in my traules, neither doe I think that any other nation in Christendome doth vse it, but only Italy. The Italians and also most strangers that are commorant in Italy, doe alwaies at their meales vse a little fork when they cut their meat."

Fyne Moryson's "Itinerary," in the reign of Elizabeth, refers to their use in Venice.

Heylin in his "Cosmograph," 1662, says: "The use of silver forks, which is by some of our spruce gallants taken up of late, came from China into Italy, and thence into England."

Table-forks have long been in use in Feejee. At a time when all Northern Europe was destitute of the article, these remarkable savages, the most cruel and ingenious of all the natives of Polynesia, used forks in conveying to their mouths morsels of *puaka-balava*, long-pig, as they called cooked man.

Table-forks of the best quality are forged from the end of a rod of cast-steel, about three eighths square. The tang, shoulder, and shank are roughly formed and cut off, the prongs being a flat portion which is stamped out by a swage drop. The film between the tines is cleaned away by the file. These processes are followed by hardening, tempering, grinding, and hafting.

Fork-beam. (*Shipbuilding.*) A half-beam to support a deck where hatchways occur.

Fork-chuck. (*Turning.*) A piece of steel projecting from the live spindle and carrying the front center and a pair of joints which enter the wood and rotate it.

Fork-head. The double head of a rod which divides in order to form a connection by means of a pin.

Fork'staff-plane. (*Joinery.*) A joiner's plane for working convex cylindrical surfaces.

Fork-wrench. A spanner with two jaws which embrace a nut or a square on a coupling.

Form. 1. (*Printing.*) *a.* A body of type, composed and made ready for printing.

b. A stereotype in the like condition of readiness.

The one containing the first page is the *outer form.* The *form* for the opposite side of the sheet is the *inner form.*

2. A shape or mold for metal, glass, or jelly.

Form'er. A shape around which an article is molded, woven, wrapped, pasted, or otherwise constructed.

A templet, pattern, or gage by which an article is shaped, as pottery, or an object in the lathe.

A cutter by which patterns, blanks, wads, or pieces are cut from sheets for various purposes.

Form'ing. (*Shipbuilding.*) Shaping exactly the converted (partially shaped) timbers, so as to give them the required figure. This consists in: —

Siding; giving them the correct breadth.

Molding; giving the correct outline and depth.

Beveling; giving the faying surface the proper shape to meet the planking or iron skin.

Form'ing-cyl'in-der. (*Paper.*) That cylinder in a paper-making machine on which the film of pulp is gathered, and which delivers it as a soft and weak web to the hardening and drying devices.

For'ril. Lambskin parchment. Vellum.

Fort. A small fortification.

The *orthography* of a fort is its profile.

The *ichnography* is its ground plan. See FORTIFICATION.

Fort'al-ice. An outwork of a fortification.

For'ties. (*Printing.*) A sheet of paper having forty printed pages on each side. 40's.

For'ti-fi-ca'tion. Fortifications are known as, —

Natural, when cliffs, swamps, rivers, etc., conduce to give the advantage to the defending force.

Artificial, when labor and skill create advantages or add to the natural ones.

Defensive, when opposed to an attacking force.

Offensive, in investing a place.

Permanent, of a lasting character.

Field, for emergency or temporary uses.

There is no room here for a treatise; see details under the following heads: —

Abattis.	Body of a place.
Ante-mural.	Bomb-proof.
Approach.	Bonnet.
Arrow.	Bonnet de prêtre.
Augette.	Boom.
Avant-fosse.	Branch.
Banquette.	Bray.
Barbacan.	Break.
Barbette.	Breast-hight.
Barrier.	Breast-work.
Bartizan.	Bridge-head.
Base.	Brisure.
Basket-work.	Bulwark.
Bastion.	Buttress.
Bastioned fort.	Caltrop.
Batardeau.	Camouflet.
Battery.	Canditeer.
Bavins.	Capital.
Berme.	Caponniere.
Blind.	Casemate.
Blindage.	Cavalier.
Block-house.	Cavin.

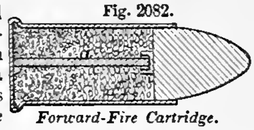
Chamber.
Chemin des rondes.
Cheval de frise.
Circumvallation.
Citadel.
Coffer.
Coffin.
Contour.
Contravallation.
Cordon.
Corridor.
Counterguard.
Countermine.
Counterscarp.
Counter swallow-tail.
Counter-trench.
Countervallation.
Counter-works.
Coupurus.
Covered way.
Cremaillere.
Crenette.
Crest.
Crotchet.
Crown-work.
Crow's-feet.
Cunette.
Curtain.
Dead-angle.
Deblai.
Demi-bastion.
Demi-lune.
Demi-revetment.
Detached works.
Ditch.
Ecoute.
Elevated battery.
Embrasure.
Enciente.
Envelope.
Epaule.
Epaulement.
Escarp.
Esplanade.
Estacade.
Exterior slope.
Face.
Fascine.
Fausse-braye.
Field-work.
Flank.
Fleche.
Fort.
Fortalice.
Fortress.
Fosse.
Fougasse.
Fraise.
Front.
Gabion.
Gallery.
Glacis.
Gorge.
Half-moon.
Half-sunken battery.
Herrison.
Herse.
Hersillon.
Horn-work.
Hurdle.
Hurter.
Indented line.
Indented parapet.
Interior slope.
Intrenchment.
Iron fortification.
Klicket.
Line.
Liziere.
Lodgment.
Loop-hole.
Lunette.
Magazine.
Magistral.
Mantlet.
Martello tower.
Masked battery.
Merlon.
Mine.
Moat.
Moineau.
Orgues.
Orillon.
Outwork.
Palisade.
Parados.
Parallel.
Parapet.
Picket.
Place of arms.
Plane.
Platform.
Plongée.
Portcullis.
Postern.
Priests' cap.
Profile.
Ramp.
Rampart.
Ravelin.
Redan.
Redoubt.
Re-entering-angle.
Relief.
Remblai.
Retired flank.
Retrenchment.
Revetment.
Revolving-tower.
Ridge.
Rifle-pit.
Rimer.
Salient-angle.
Sally-port.
Sand-bag.
Sap.
Sap-roller.
Saucisse.
Scarp.
Shoulder.
Sill.
Sillon.
Slope.
Sole.
Spur.
Star-fort.
Stockade.
Sunken battery.
Superior slope.
Swallow-tail.
Tenailles.
Tenaillon.
Terre-plein.
Tete de pont.
Tower.
Trace.
Traverse.
Traversing-platform.
Trench.
Trench-cart.
Trench cavalier.
Trous de loup.
Turret.
Van-fosse.
Zigzag.

For'tress. A large permanent fortification, such as, on our continent, Fortress Monroe, Quebec, St. Juan de Ulloa, Moro Castle. They are too numerous in Europe to be thus summarily cited.

For'ty-eightmo. (*Printing.*) A book made up of sheets printed 48 pages on a side. 48mo.

For'ward-fire Car'tridge. One in which the fulminate is at or in the base of the ball, forward of the powder. It is exploded by a stem *d*, as in the figure, or else by a needle which penetrates the whole extent of the powder, and strikes the fulminate in the base of the bullet. See NEEDLE-GUN.

Fig. 2082.



Forward-Fire Cartridge.

For'ward-ing. (*Bookbinding.*) That department which concerns the operation of plain covering a sewed book, ready for the finisher.

Fosse. (*Fortification.*) A moat or ditch around a fortification.

An *advance fosse* is a ditch encircling the glacis or esplanade of a fortification.

Foth'er-ing. (*Nautical.*) A mode of stopping a leak at sea by thrumming a sail with oakum and yarn and drawing it under the bottom so as to clog the aperture.

Fou'cault's Pen'du-lum. A pendulum for rendering visible the diurnal motion of the earth.

It consists of a *bob* suspended from a considerable hight, say the apex of the dome of the Pantheon or Capitol, and set to vibrating above a circular table marked with degrees. Owing to certain independence of motion which the *bob* possesses, vibrating in space, as it were, the earth in its diurnal motion turns round beneath it, as is evidenced by the *apparent* change of direction of the *bob* relatively to the graduated table. See PENDULUM.

Fou-gasse'. (*Fortification.*) A small mine, consisting of a hole charged with combustibles and projectiles hidden by earth, and placed in a position liable to fall into the hands of the enemy.

Fou-lard'. (*Fabric.*) A thin silk or silk-and-cotton dress-stuff.

Found. 1. A three square, *single-cut* file or *float*, with one very acute angle, used by comb-makers. See COMB.

2. To cast; as metal.

Foun-da'tion. 1. The bed or basis of a structure.

2. (*Hat-making.*) The body of a hat, of wool or inferior fur, upon which the napping of superior fur is laid and united at the *battery*.

Foun-da'tion-bolt. One which keeps a bed-plate — of an engine, for instance — down to its substructure.

Foun-da'tion-muslin. (*Fabric.*) An open-worked, gummed fabric, used for stiffening dresses and bonnets.

Foun-da'tion-pile. (*Hydraulic Engineering.*) One driven into soft or treacherous ground to form — with others — an unyielding basis for a structure.

Foun-da'tion-plate. 1. (*Bookbinding.*) The base plate on which ornaments are arranged in the stamping or embossing press.

2. (*Steam Engineering.*) The bed-plate of a steam-engine.

Found'er's Cleans'ing-mill. A *tumbling-box* in which small castings are cleansed from adhering sand. In a similar box articles may be polished or rounded by mutual attrition, assisted, if need be, by an abradant, such as sand or emery.

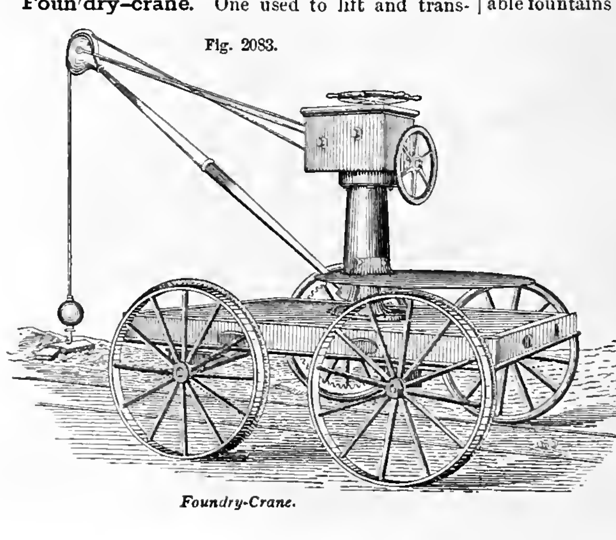
Found'er's-lathe. A lathe used in preparing the cores for loam-molding, such as those for iron pipes. A central spindle, being prepared, is placed on centers or on V's, and the clay loam covering is plastered on and regulated by a templet or pattern.

Found'ing. The art of casting metals. See under the following heads: —

Blackening.
Casting-box.
Casting-ladle.
Chamber.
Cheek.
Chill.
Chipping-piece.
Cleaner.
Cliché.
Compression-casting.
Contraction-rule.
Core.
Core-bar.
Core-box.
Core-print.
Crucible-tongs.
Dead-head.
Dryer.
Facing.
False core.
Flask.
Flask-clamp.
Follow-board.
Founder's lathe.
Gagger.
Gate. Geat.
Gland.
Grunter.
Hollow board.
Ingate.
Ladle.
Lingot.
Loam.
Loam-cake.
Mantle.
Match-plate.
Matrix.
Mold.
Molder's clamp.
Molder's flask.
Molder's table.
Mold-facing.
Molding and casting apparatus.
Molding-board.
Nowell.
Parting.
Perier.
Pickle.
Pig.
Plasm.
Rammer.
Runner.
Sand.
Shank.
Shuttle.
Slicker.
Sow.
Spill-trough.
Spray.
Sprue.
Stalk.
Statuary-casting.
Steady-pin.
Stopping-off.
Strickle.
Strike.
Sullage.
Tamping-bar.
Tedge.
Tile.
Trowel.
Tumbler.
Tumbling-box.
Undercut.

Foun'dry-crane. One used to lift and transport molds, flasks, castings, etc., in a foundry. Also known as a molding-crane, from its being used for lifting into and out of position the drags of molds, cores, and what not, in heavy casting, loam-work, and pit-casting. See CRANE.

Fig. 2083.



Foundry-Crane.

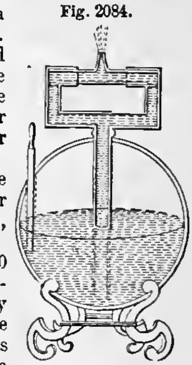
Fount. An assortment of printer's type. See FONT.

Foun'tain. 1. An upward jet of water, natural or artificial. With the latter we have alone to do.

Many ingenious pneumatic and hydraulic devices are shown in "Spiritalia Heronis," 150 B. C. Some were toys merely, and some, probably, were a part of the illusive machinery of the temples.

In the fountain of Hero, the motion of a column of water is transmitted to another by the intervention of a body of air between the two. The pressure of the elevated body of water compresses the air in a lower chamber; the pressure is transmitted to the air in a chamber above, the water of which is ejected in a jet.

Fig. 2084.



Hero's Fountain (150 B. C.).

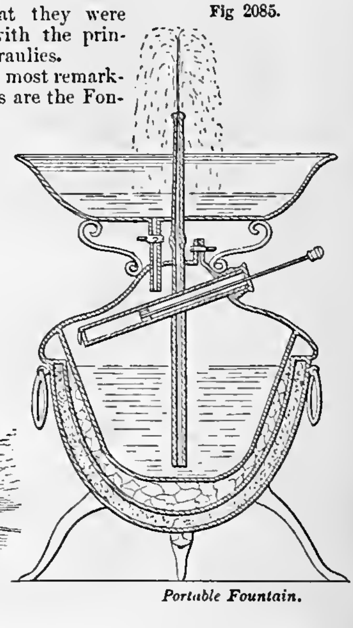
The principle has been made use of in emptying the water from the mines of Schemnitz, Hungary. (See Fig. 58.)

Hero has anticipated by 2,000 years some of the modern parlor fountains, in which a body of compressed air above the water in the reservoir below is made the means of driving a jet of water into the air. An adjustment in two planes is given to the nozzle, so as to direct the stream in the required direction.

This contrivance, which appears simple enough when exhibited in section, was one of the hydraulic marvels of the pagan priests. Fig. 2085 is a late form, which has an ice-chamber and non-conducting casing. The gardens of Montezuma were adorned and nourished by streams and fountains. For the former they were indebted to extensive aqueducts. The possession of the latter shows that they were acquainted with the principles of hydraulics.

Among the most remarkable fountains are the Fon-

Fig 2085.



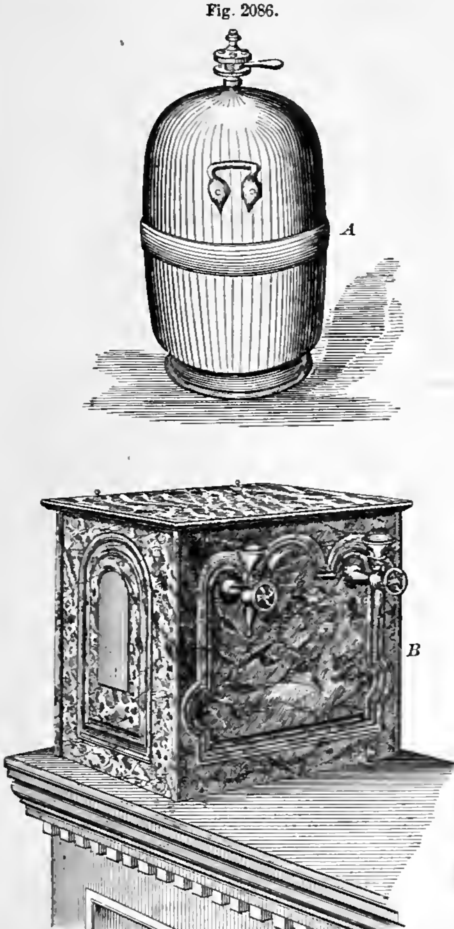
Portable Fountain.

tana di Trevi at Rome, constructed for Pope Clement XII. in 1735; the Fontana Paolina, erected for Pope Paul V. in 1612; the Fontana dell' Acqua Felice, or Fountain of Moses. The fountains of Versailles, made for Louis XIV., and the Jet d'Eau of St. Cloud, are much admired. The fountains of Chatsworth, in Derbyshire, England, the residence of the Duke of Devonshire, are particularly grand; as are also those of the Crystal Palace at Sydenham, near London. Cincinnati is also proud of a fountain made in Germany, and of a very Teutonic aspect.

2. The "beer fountain," as it is called, used for drawing liquors in a tavern bar from barrels in the cellar, by means of a force-pump, is the invention of Bramah, and was patented by him.

3. A copper vessel *A* (Fig. 2086) containing aërated water for a beverage. It is used in connection with

Fig. 2086.



Soda-Fountain.

an ornate counter arrangement through which the liquid is drawn into tumblers. They are lined with block-tin to prevent corrosion of copper.

4. A box *B* containing ice and a coil through which aërated water, known as "soda-water," is conducted to the nozzle, when it is drawn into glasses.

The sirup fountain is for the supply of the sirup which flavors the "soda," so called.

5. An upper reservoir chamber to contain a liquid and supply a wick, a dip-hole, a trough, etc. As in the oil-chamber of an Argand lamp, the reservoir of an inkstand, a drinking-glass in a bird-cage, etc.

6. The ink-reservoir in a printing-press.

7. The supply-chamber in a reservoir pen.

Foun'tain Ink'stand. One which has a continual supply of ink from an elevated fountain (see Fig. 2087), or which has an elastic diaphragm by which the dip-cup may be supplied or emptied, as in Fig. 2088.

Fig. 2087.

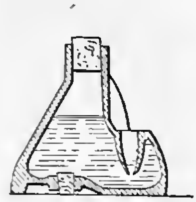
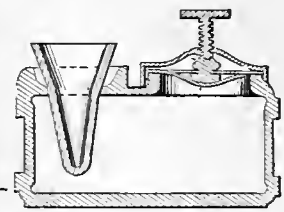


Fig. 2088.



Fountain-Inkstands.

Foun'tain-lamp. One with an elevated reservoir for supply, as in most forms of the Argand, — the student's lamp, for instance.

Gerard used an air-pump to force oil from a low chamber to the burner of an Argand lamp, so as to avoid throwing a shadow upon surrounding objects.

Foun'tain-pen. One which has an ink reservoir for the supply of the pen.

Scheffer's fountain-pen, introduced in England about 1835, had a reservoir of ink in the holder, and the ink is admitted to the pen by the pressure of the thumb on a projecting stud.

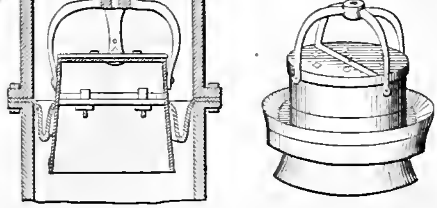
Fig 2089.

Fountain-Pen.

Parker's hydraulic pen, invented about the same time, had a piston in the holder, operated by a screw stem and a nut on the end of the holder. The lower end of the reservoir being dipped in ink, the piston was drawn up by rotating the nut, filling the reservoir. The ink was ejected as required by the contrary motion of the thumb-nut.

Foun'tain-pump. 1. One in which a stream with a natural head is led through a

Fig 2090.



Fountain-Pump.

stock and nozzle, and thus bears the appearance of a pump, though perennial.

2. One in which a packed piston is replaced by a plunger with a leathern annular disk or diaphragm.

Four-cant. (*Nautical.*) A rope of four strands.

Four-chette'. 1. (*Surgical.*) An instrument for holding up the tongue while the frenum is being cut.

2. (*Glove-making.*) The forked piece between two adjacent fingers of a glove, uniting the portions of the back and inside of the finger. *Fougette.*

Four'dri-nier'-ma-chine'. A paper-making machine, the first to make a continuous web. It was invented by Louis Robert, of Essonne, and patented by him in France. He experienced some pecuniary difficulties, and sold the right to M. Leger-Didot. The latter came to England and made arrangements for working it. A Mr. Gamble and the brothers Fourdrinier improved it, and made a valuable machine which was pirated, and bankrupted the gentlemen whose name is imperishably associated with it. The enterprise is the glory of the mechanical genius, and the disgrace of the law lords and law courts of the "tight little island."

The machine was perfected by Bryan Donkin, John Wilks, and others not known to fame.

The essential features of the machine are: —

1. A stream of paper pulp flowing on to the surface of an endless, horizontal, wire web.

2. A tremulous motion to the web to shake out the water, which falls in a rain beneath, and to felt the fiber.

3. A traveling deckle which keeps up with the motion of the web, and forms the lateral margin of the paper.

4. A porous *dandy* which presses the pulp and absorbs some of the water.

5. A couching roller to take up the web.

6. A pressure roller to abstract moisture.

7. Drying, sizing, finishing, measuring, cutting devices, *ad. lib.* See PAPER-MACHINE.

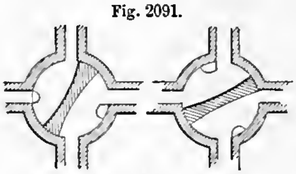
Four'gon. 1. A tumbrel or ammunition-wagon.

2. A French baggage-vehicle.

Fourth-rate. Formerly a 50 to 70 gun vessel, now a gunboat carrying from 1 to 4 guns.

Four-way Cock. A cock having two separate passages in the plug, and communicating with four pipes. The invention of James Watt.

Fig. 2091.



Four-Way Cock.

Fowl'ing-piece. A fire-arm adapted for ordinary sporting. See FIRE-ARM.

Fox. (*Nautical.*) A small strand of rope made by twisting several rope-yarns together. Used for *seizings, mats, sennits, gaskets.*

Fox-bolt. A description of bolt which is made tight by a *fox* or wedge driven into a split in the end. See BOLT.

Fox'ing. (*Shoemaking.*) 1. An outer covering or upper leather over the usual *upper.* One mode of repairing a worn upper by clothing it.

2. Ornamental strips of a different material on the uppers of shoes.

Fox-key. (*Machinery.*) A split-cotter with a thin wedge of steel driven into the end to prevent its working back.

Fox-tail Saw. A dovetail saw.

Fig 2092.

Fox-Tail Wedging.

Fox-tail Wedg'ing. A mode of spreading the end of a tenon in the mortise, so as to give it a dovetail character to resist withdrawal. The same is applied to wooden pins which occupy holes not bored through. In the point of the pin is inserted a thin wedge of hard wood. When this reaches the bottom of the hole, it sinks into and spreads the end of the pin so as to bind it very firmly in the hole.

With a tenon, it is usual to insert a number of small wedges, so that it may not be split much at any one point.

Fox-type. (*Photography.*) A printing process in which a transparent positive is used, and the action of the light is the reverse of the usual process.

Foy'er. The crucible or basin in a furnace, to receive the molten metal.

Frache. A shallow iron pan to hold glass-ware while being annealed in a *leer.*

Frag'ments. (*Printing.*) A few pages at the end of a book. The title, preface, contents, etc., imposed so as to print off economically. *Oddments.*

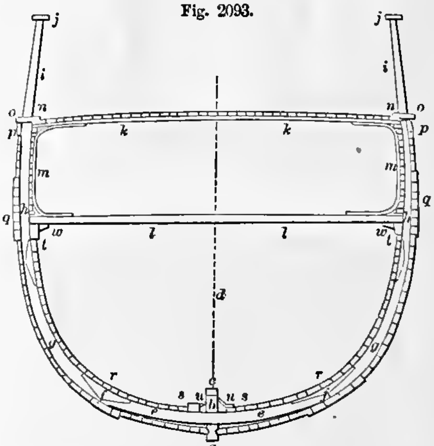
Fraise. 1. (*Fortification.*) Palisading placed horizontal at the crest of the scarp and projecting over the ditch.

2. A tool used by marble-workers to enlarge a hole made by a drill. It is grooved, and slightly conical.

Frame. The skeleton of a structure.

1. (*Shipbuilding.*) The parts of a ship's frame are shown in Fig. 2093, which represents a midship section.

Fig. 2093.



Ship's Frame.

a, keel.
b, keelson.
c, keelson-rider.
d, middle line or center line.
e, floor-timber, ground-futtock, or navel-futtock.
f, chock for filling to the timbers.
g, second futtocks.
h, top timbers.
i, rough-tree timber or stanchion.
j, rough-tree rail, or rail.
k, upper-deck beam.
l, hold-beam.
m, standard knees.
n, water-ways.
o, plank-shears.
p, sheer-strakes.
q, wales.
r, bilge-planks, inside and out.
s, futtock-planks.
t, clamps or sea-crafts.
u, limber-boards.
w, shelf-pieces or stringers.

2. The strong work which supports the engine and boilers of a locomotive upon the wheels, and known as *inside* frame or *outside* frame, according to the position of the wheels relatively to the frame.

3. The head of the batten in a loom.

4. The ribs and stretchers of an umbrella, or other structure with a fabric covering.

5. (*Carpentry.*) *a.* The skeleton structure of a wooden building, consisting of sills, posts, beams, sleepers, joists, and rafters, with the studding that is to form partitions.

b. The outward work enclosing a door or window.

c. The part of a door or window enclosing panels.

d. A border or inclosure for a picture, or panes of glass.

6. (*Horology.*) That which contains the mechanism of a watch or clock. It consists of two *plates* and a sufficiency of *pillars;* usually four.

7. (*Printing.*) A desk containing two pairs of cases, containing roman and italic letters for the use of a compositor (see CASE), or the stand supporting them.

8. A structure of four bars arranged in a square and adjustable in size, on which cloth or other fabric is stretched for quilting, embroidery, etc.

9. A term applied, especially in England, to machines built upon or within a framework of timbers — e. g. the *stocking-frame, lace-frame, water-frame, silk-frame,* etc. It is one degree more complex than the *quilting-frame, tambour-frame, embroidery-frame, glass* or *picture frame ;* or a *window* or *door frame.*

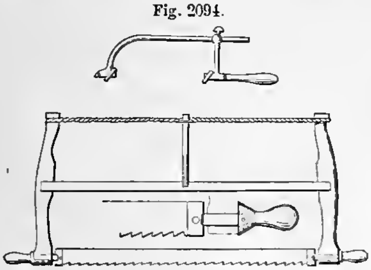
10. (*Soap-making.*) A box whose sides are removable when required, and locked together when the soap is to be poured in. As soon as the soap has acquired sufficient solidity, the sides are unlocked and taken down, exposing the block of soap, which is then cut up by wires which are passed through it to divide it into parallelopipeds.

Frame-lev′el. A mason's level.

Frame-saw. A thin saw stretched in a frame which gives it sufficient rigidity in its work.

The *buhl-saw,* for enlarging, is of this character. It is common to make the handle-attachment at each

Fig. 2094.



Frame-Saws.

end rotatable, so as to present the saw-edge in any direction.

A frame-saw is shown in a painting at Herculaneum. The sawyers are at each end, one standing and the other sitting. The bench to which the timber is secured by cramps is supported by four-legged stools. The saw-frame is square and the saw-blade is strained in the middle ; the teeth stand perpendicularly to the plane of the frame.

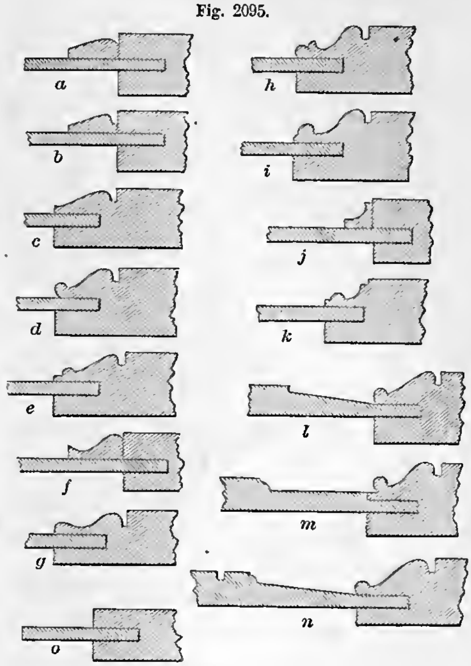
Frame-saws were common in Egypt many centuries previous to this time.

Fram′ing. 1. A mode of putting parts of a structure together

Joinery framing is of various descriptions, as square, bead, bead and fillet, ogee, etc., etc. See the following examples, which all have *flat panels and square backs :* —

a, ovolo and square.
b, quirk-ovolo.
c, quirk-ovolo fillet.
d, quirk-ovolo bead.
e, quirk-ovolo cock-bead or bead and fillet.
f, ogee and square.
h, quirk-ogee and quirk-bead.
g, quirk-ogee.
i, quirk-ogee, bead, and fillet.
j, cavetto.
k, cavetto, bead, and fillet.

Fig. 2095.



Joining-Framing.

The following vary in the *panels :* —

l, quirk-ovolo and bead, raised panel and square back.

m, quirk-ovolo and bead, raised panel with ovolo on the rising, and square back.

n, quirk-ovolo and bead, raised panel, with ovolo on the rising groove round the face, and square back. The list might be much extended.

o is square-framing, the simplest description of framing, having no molding on either side.

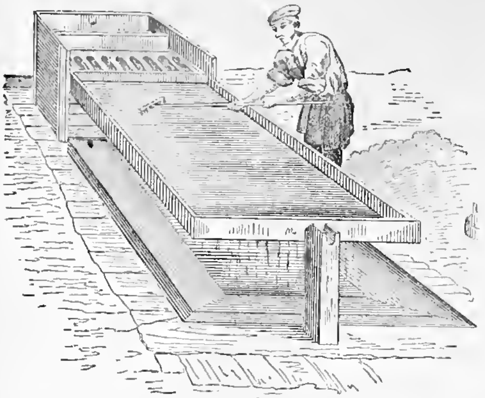
2. (*Mining.*) An operation upon pounded or stamped ores by which they are sorted into grades of comparative weight and consequent richness.

The *framing-table* is eight feet long, four feet wide, and has a ledge around it. It is suspended in an inclined position, on pivots, so that it may be tipped into a vertical position when full, discharging its contents into separate cisterns beneath ; the reason for the separation of the receptacles will be apparent presently.

At the upper end of the frame is the jagging-board, over which the sluices are so distributed that a small stream of water shall carry them gradually down on to the frame. The richer portions of the ore rest upon the upper part of the frame, and the poorer, lighter portions are carried farther down ; light impurities escape with the water at the lower part of the frame. The ore on the frame is occasionally stirred with a rake, that every portion may be subjected to the action of the water.

When the *frame* is sufficiently full, the latch which held it horizontal is lifted, and the frame tipped up into a vertical position, so as to tip out its contents, which fall into the vats beneath. These

Fig. 2096.



Framing.

vats are arranged in a row, so that they may respectively receive the *slimes* which have accumulated nearer to or farther from the head of the frame, the richness being determined by the proximity to the head or upper portion. The frame is then readjusted, a quantity of slimes spread on the *jagging-board*, and the operation recommences.

The contents of the cisterns are treated by subsequent processes of a nature adapted to their respective qualities. Analogous processes are described under BUDDLE; TRUNK; KEEVE; JIGGER; TYE, etc. (which see).

Fram'ing-chis'el. (*Carpentry.*) A heavy chisel for making mortises. It has a socket-shank which receives the wooden handle on which the blows of the mallet are delivered.

Frank'ing. (*Joinery.*) The notching out a portion of a sash-bar for the passage of the transverse bar, to make a miter-joint.

Frap'ping. 1. (*Nautical.*) *a.* The binding together of the several ropes of a tackle at a point between the blocks, so as to increase still farther the tension.

b. Securing a ship in emergency by wrapping ropes around it, to prevent starting of the planks.

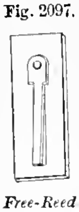
"They used helps, undergirding the ship." — *Luke's account of Paul's voyage.*

2. Bracing the cords of a drum by pulling them together.

Free'board. (*Shipwrighting.*) So much of the vessel's side as is included between the *plank-sheer* and the water-line.

Free-reed. (*Music.*) An elastic tongue, usually of brass, and playing in a long rectangular opening in a plate to which one end of it is riveted. The name *free-reed* is given to distinguish it from the reed which batters against the seat, as in the clarinet, some organ-pipes, the bassoon, and oboe. These *battering*-reeds are usually of wood. The *free-reed* is used in the accordeon, melodeon, concertina, harmoneon, parlor-organ, and in most of the reed-pipes of organs.

Fig. 2097.



Free-Reed.

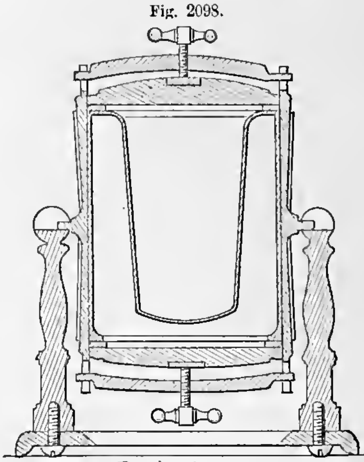
The opening in the plate is slightly larger than the margin of the tongue, so that the portion of the latter concerned in the vibration does not batter against or touch the plate. At one end is a stud by which the plate is drawn in or out from the seat of the reed over the aperture whence it derives the air-blast producing the vibration and the consequent musical tone. At some point on the plate is denoted the note to which the tongue is tuned.

Free'stone. An oölitic stone, so called from the facility with which it is rived in any direction.

Free-stuff. (*Carpentry.*) Timber free from knots. *Clear-stuff.*

Freez'er. An apparatus in which cream or other food is placed to be frozen. In the example, the liquid to be congealed or cooled is contained in a metallic cylinder inclosed by another cylinder and surrounded by the chemical refrigerating substances, the apparatus being rotated or oscillated to thoroughly agitate the liquids, and bring new particles to the cold surface.

Fig. 2098.



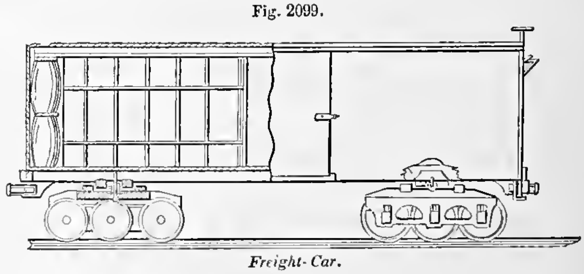
Freezing-Apparatus.

Master's machine for icing drinks consists of a central cylinder for the confectionery, a surrounding cylinder for the freezing mixture, and one outside of this again, for containing water. The inner cylinder is rapidly revolved, its contents become frozen, and the water in the outer vessel becomes a hollow cylinder of ice, in which a decanter may be set to ice its contents.

Freez'ing-mix'ture. A mixture of salt and pounded ice; or a combination of chemicals with or without ice. See ICE-MAKING.

Freight-car. One constructed for the carriage of merchandise.

Fig. 2099.



Freight-Car.

Freight-en'gine. (*Steam Engineering.*) A locomotive adapted for drawing heavy trains at moderate speed. The drivers are coupled together so as to increase adhesion, and are of smaller diameter than usual with passenger engines adapted for more rapid transit.

French-bit. (*Carpentry.*) A boring tool adapted to use on a lathe-head or by a bow. It is intended for boring hard wood, and approaches the characteristics of a *drill*. See BIT.

French-fly'ers. (*Carpentry.*) Stairs that fly forwards until they reach within a length of a stair from the wall, where a quarter space occurs; the steps next ascend at a right angle, when another quarter space occurs; they then ascend in an opposite flight, parallel to the first direction.

French-horn. A wind-instrument formed of metal, having a circular shape and a gradual taper from the mouth-piece to the flaring pavilion. See HORN.

French-pol'ish. A solution of resin or gum resin in alcohol or wood naphtha. A good recipe is, shellac, $1\frac{1}{2}$ pounds; spirits of wine, 1 gallon. Or, shellac, $2\frac{1}{2}$ lbs.; gum mastic and sandarac, each 3 ounces; alcohol, 1 gallon; copal varnish, 1 pint. Or for a dark color, shellac, 1 pound; benzoni, $\frac{1}{2}$ pound; alcohol, 1 gallon. Or, shellac, $1\frac{1}{2}$ pound; guaiacum, $\frac{1}{4}$ pound; alcohol, 1 gallon.

It is laid on with a sponge, a brush of wadding enveloped in a rag, or a rubber made of a roll of list. These are saturated with the varnish which they gradually yield by pressure to the surface of the wood, over which they are kept in constant motion in uniform circular strokes. The surface of the rubber is covered with an oiled cloth, which is renewed as it becomes clogged.

French-roof. A roof having portions of two different pitches. A *curb* roof. A *Mansard* roof.

French-win'dow. A large casement window, moving on hinges instead of sliding vertically in grooves. A *casement*.

Fres'co. A mode of painting in which the colors are mixed with and laid on in the manner of plaster.

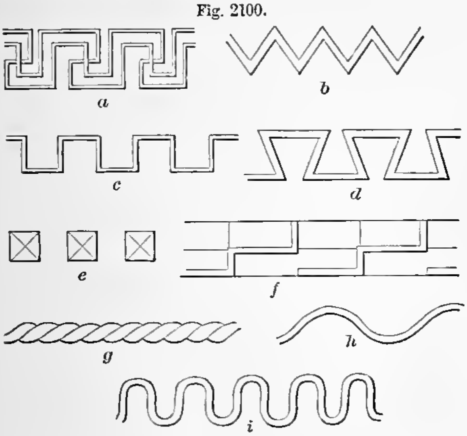
The picture is prepared as a cartoon, and is pricked through on to the soft surface of plaster upon which the fresco is to be placed.

The surface is rough, and is damped to receive the colors, which are mixed and ground up with lime.

A solution of silex instead of lime was used by Oberrath von Fuchs, being laid on a chemically prepared ground. It becomes exceedingly hard.

Fret. 1. An ornament of zigzag, interlacing, or variously contorted fillets, used as an architectural

Fig. 2100.



Frets.

decoration. Some frets are included in the following: —

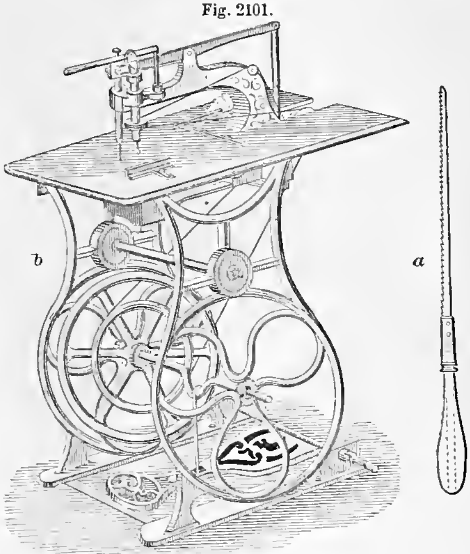
a, intersecting fret.
b, zigzag or chevron molding.
c, embattled fret.
d, triangular fret.
e, nail-head fret.
f, billet-fret.
g, cable-molding.
h, wavy molding.
i, nebular molding.

2. (*Music.*) One of the bars of wire on the finger-board of a guitar and some other instruments, to indicate where the fingers are to be placed for playing certain notes.

Fret-saw. 1. A saw (*a*) with a relatively long, narrow blade, used in cutting the frets, scrolls, etc., on verge boards, ornamented screens, etc. A *key-hole saw*; a *compass-saw*.

2. A machine (*b*) mounted on a stand with a treadle to give the reciprocating motion to the gig-saw. The

Fig. 2101.



Fret-Saw.

machine shown is specially intended for fret-work on a small scale, ornamental inlaying, buhl and reisner work (which see).

Fret-work. 1. (*Glazing.*) A mode of glazing in which a number of separate pieces of stained glass are fitted together in leaden *cames* so as to form patterns. The *cames* are fastened by leaden bands to *saddle-bars* of iron, which cross the window-frame.

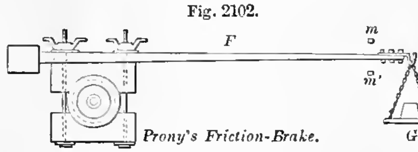
2. (*Wood.*) Carved or open wood work in ornamental patterns and devices.

Fri'ar. (*Printing.*) A pale patch in a printed sheet.

Fric'tion-balls. Balls placed beneath a traversing object to relieve friction. Some forms of swing-bridges are thus supported. Properly, *anti*-friction balls.

Fric'tion-brake. A form of dynamometer in-

Fig. 2102.

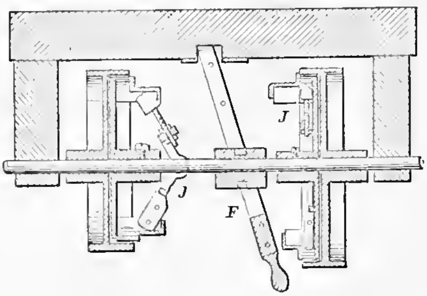


Prony's Friction-Brake.

vented by Prony, in which a pair of friction-blocks are screwed to a journal rotating at a given speed, and tightened to such an extent that the unweighted lever will remain horizontal between the studs *m m'*.

The shaft is now set in motion by the prime mover, the screws are then gradually tightened to such a degree that the shaft moves exactly with the velocity at which its useful effect has to be determined. Were it not for the stud *m*, the lever, with the whole brake apparatus, would move round in a circle with the shaft, so that this stud has to withstand a certain force from the lever pressing against

Fig. 2103.



Brown's Friction-Clutch.

it. Now place gradually upon *G* such a weight as will counteract the pressure of the lever against *m*, and bring it back to its horizontal position. It is evident that this weight, in combination with the lever *F*, expresses the amount of friction between the blocks and the drum.

Fric'tion-clutch. A device for connecting two shafts by bringing a piece on one shaft in contact with a piece on another shaft, which revolves with such force that the former partakes of the motion of the latter.

In Fig. 2103, the shipper-handle *F* carries the shaft, and with it the toggles *J J*, expanding the segments against the rim of the pulley. See also CLUTCH.

Fric'tion-cones. A form of friction-coupling in which the connecting portions have respectively a conical disk and a hollow cone, which become frictionally adherent by contact.

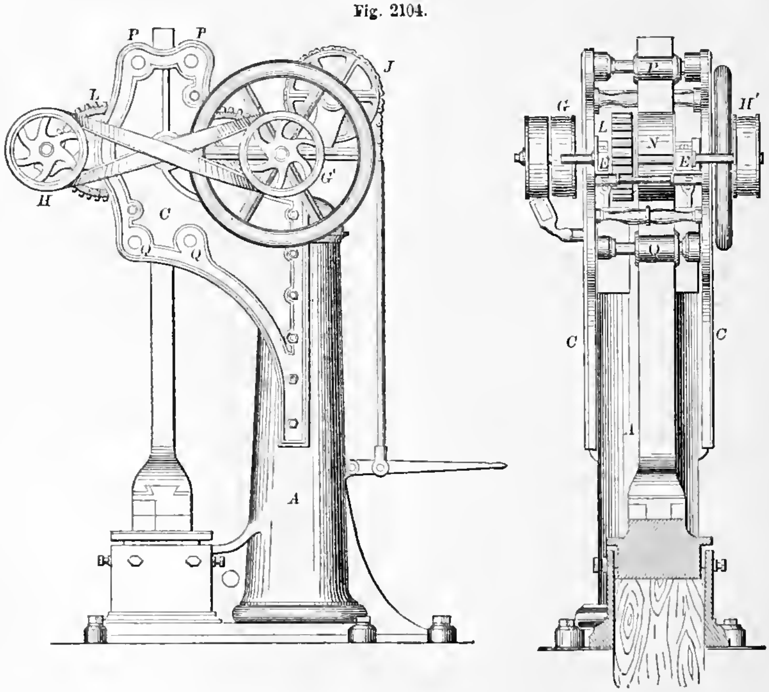
Fric'tion-coup'ling. See FRICTION-CLUTCH.

Fric'tion-gear. Wheels which act upon each other by the adhesion of their contacting surfaces, instead of by cogs, bands, or chains.

Fric'tion-ham'mer. One deriving its name from the hammer being lifted by means of the friction of revolving rollers, which nip the hammer-rod. The framework consists of a pillar *A*, to which are bolted the two cheeks *C C* carrying the working apparatus. On the oscillating frame *E E* are the plummer-blocks for the spindles, carrying the driving gear and friction-rollers. The motion is, in the first instance, communicated to the drum *G*, and consequently to *G'*, fixed upon the same shaft; this communicates the motion by means of a crossed strap to the drum *H*, and hence also to a pinion which works into the spur-wheel *L* fixed upon the same shaft with the friction-roller *N*. In a similar manner, a friction-roller on the other side of the hammer-rod is set in motion by means of a spur-wheel and pinion deriving motion from the drum *G'*.

The friction-rollers have wooden rims. The oscillating frame *E*, when tilted upon its axis, causes the friction-rollers to nip the hammer-rod, the one a little above, the other a little below, the axis. When the frame *E* resumes its horizontal position, the hammer is allowed to fall, being guided by the rollers *P P* and *Q Q*. The tilting of the frame is done by means of the lever, connected with the same by means of the rod and chain passing over the fixed pulley *J*.

Fig. 2104.



Friction-Hammer.

Fric'tion-pri'mer. A small brass tube filled with gunpowder, and having a smaller tube containing friction composition inserted at right angles near the top. The composition is ignited by means of a roughed wire inserted in the smaller tube, which is rapidly drawn out by a lanyard having a hook at the end.

The composition consists of 2 parts sulphuret of antimony and 1 part chlorate of potassa, moistened with gum water and dried.

Fric'tion-pul'ley. See FRICTION-CLUTCH; CLUTCH.

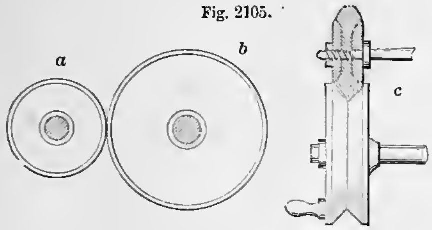
Fric'tion-tube. (*Ordnance.*) A tube containing a composition which is inflamed by friction, and which is placed in the vent of a gun to ignite the charge when the lanyard is pulled. See FRICTION-PRIMER.

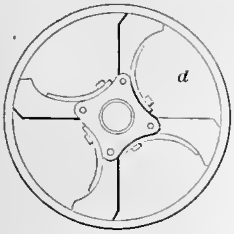
Fric'tion-wheel. A wheel the motion of which is caused by the friction of a moving body, or, conversely, which communicates motion to a body by frictional contact. In the annexed illustration *a b*, one wheel being driven becomes a motor to the other, their perimeters being in contact. The surface is usually clothed with leather, rubber, or some sufficiently elastic material which does not polish too readily, and thus induce slipping.

By grooving the perimeters of the wheels, the contact may be made more intimate, as the surface engaged is increased, and the elastic material of the respective faces caused to bind.

The term *friction-wheel* is often, but erroneously, applied to wheels which diminish friction; these are properly called ANTI-FRICTION WHEELS (which see.)

Fig. 2105.





Friction-Gearing.

Howlett's friction gearing *c* has an upper india-rubber wheel with a V-edge, clamped between two metallic plates. By screwing up the nut which holds the parts together, the disk is made to expand radially, and thus increase the tractive power on the lower driving-wheel.

d shows another form. A collar fastened to the central shaft has four pivoted arms. When the rim turns in one direction, the arms turn on their pivots, leaving the rim and failing to transfer the motion to the shaft.

When the rim turns in the contrary direction, the arms catch against it and are rotated by the contact, turning the shaft also.

The friction-wheel feed, by which logs are fed to the gang-saws in the large lumber-mills of Ottawa, Canada, consists of a horizontal wheel 40 inches in diameter, and an upright one driven by band from the engine-shaft, and 24 inches diameter. (See Fig. 1601.)

The horizontal wheel is vertically adjustable by a hand-wheel and shaft on the working floor of the mill, the friction-wheel slipping on a spline. As the said wheel approaches towards the center of the driving-wheel, the speed of the feed is lessened, and conversely; if it cross the center, the motion is in the other direction, and the feed is reversed.

Frieze. 1. (*Architecture.*) A flat member of an entablature between the architrave and cornice.

Frieze-panel; one of the upper panels of a six-panel door.

Frieze-rail; the one next to the top rail.

2. (*Fabric.*) A coarse woolen cloth.

Frig'ate. (*Vessel.*) The original frigate was a Mediterranean vessel propelled by sails and oars.

It is now a vessel of war, having an upper flush deck (spar-deck) and one covered gun-deck (main-deck). The armament is from 28 to 44 guns. The grade is below a man-of-war and above a *corvette*. The rating of iron-clads is different; the guns being larger and fewer in number.

Frig'a-toon. A Venetian vessel with a square stern, main-mast, jigger-mizzen, and bowsprit.

Frig'er-a-to-ry. A cooling-chamber.

A chamber maintained at a low temperature for the preservation of meat or vegetables.

Frill'ing. A species of plaited or fluted edging or trimming of fine linen. The gathered or plaited edge is sewn to a band, and the crimped or ruffled edge forms a collar, a cuff, or an ornament to a shirt-front.

Fringe-loom. One in which the weft-thread is carried and detained beyond the limit of the warp, which has thus a series of loops beyond the selvage.

Frisk'et. (*Printing.*) A rectangular frame having tapes, cords, or paper stretched across it for holding the sheet to the *tympan*.

The frisket is a frame around the type-form, and keeps the margin of the paper clean.

Frit. (*Glass-making.*) A calcined mixture of sand and fluxes ready to be melted in a crucible to form glass.

The term is also applied to other vitreous combinations or compositions for use in manufacturing. It is not applied to manufactured articles, but to those in course of conversion, as the calcined kelp and lead, which are ingredients in the glaze of delft-ware.

A *frit-mixer* is a horizontal cylinder with oblique beaters, or a box with semi-cylindrical bottom and a rotating shaft with beaters or stirring arms.

Frit-brick. (*Glass-making.*) A lump of calcined glass materials, which have been united and brought to a pasty condition in a reverberatory furnace preliminary to the perfect vitrification in the melting-pot. See FRITTING-FURNACE.

Frith. (*Hydraulics.*) A fish-weir.

Frit'ting-fur'nace. (*Glass-making.*) A reverberatory furnace in which the materials for making glass are calcined (*fritted*) as a process preliminary to melting. The object is to effect a partial union of the silicic acid and alkali, to avoid volatilization of the latter in the subsequent vitrification.

The materials (sand, chalk, soda-ash, and cullet) being introduced into the furnace, the temperature is gradually raised for three hours. The pasty mixture is stirred, and the temperature increased to incipient fusion. The stuff is then raked out and transferred to the melting-pot, or is placed in cast-iron trays, cut into blocks by a spade, and stored away as *frit-bricks*.

Fri'zel. The movable plate of steel placed vertically above the pan of a gun-lock to receive the blow of the *snaphance*. The form of flint-lock which superseded the wheel-lock.

Friz'zing. 1. (*Leather-manufacture.*) A process to which *chamois* and *wash* leather are subjected after the skins are *unhaired*, *bated*, *scraped*, *fleshed*, and *raised*.

It consists in rubbing the skins with pumice-stone or a blunt knife till the *grain* appearance is entirely removed, the surface softened, and an even thickness obtained throughout.

2. (*Fabric.*) A peculiar finish given to certain kinds of cloth. See next article.

Friz'zing-ma-chine'. 1. (*Fabric.*) A machine on which the nap of woolen cloth is formed into a number of little prominences or tufts. Petersham cloth, so called, is thus formed.

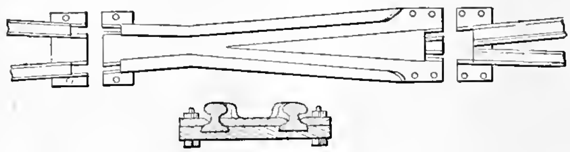
The machine consists of three parts, — the *frizzer*, the *frizzing-table*, the *drawing-beam*. The cloth is drawn by the beam between the two former portions, which are respectively about ten feet long, fifteen inches wide, and laid parallel, a short distance apart. The *table* is underneath, and its upper surface is covered with a coarse nappy cloth. The *frizzer* has a slow semicircular motion, and its surface is incrusted with a cement composed of glue, gum-arabic, and yellow sand.

The *drawing-beam* is covered with sharp points, and drags the cloth between the frizzer and the table, the latter preventing its being shifted about by the rotary reciprocation of the frizzer above, whose numerous protuberances catch the fibers of the cloth under treatment and roll them into little aggregated tufts or bunches, as the cloth is fed gradually through.

2. (*Wood-working.*) A bench with a circular cutter-head slightly protruding above the working surface, and adapted to dress boards which are passed over it.

Frog. 1. A section of rail at a point where rails diverge, or one track leads to two branches. In the illustration, a feature of connection is introduced,

Fig. 2106.



Railway-Frog.

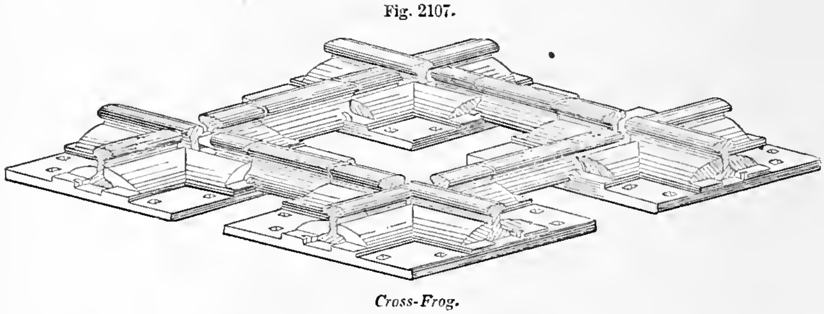
the end of the frog being dovetailed to receive the necks of the rails, and a chair placed under the dovetailed end. The chair has one or two recesses to support the rails, and suitable holes to receive the bolts.

A *cross-frog* is one placed at a rectangular intersection of railroad tracks.

2. A button or toggle of spindle shape and covered with silk or other material, which is passed through a loop on the opposite side of the breast of a military cloak or overcoat, serving to fasten the two breasts together.

3. The loop of a bayonet or sword scabbard.

Fig. 2107.



Cross-Frog.

Frog-plate. An accessory to the compound microscope in which the web of a frog's foot is exposed on the stage, to exemplify the circulation of the blood.

Front. (*Fortification.*) Two half-bastions and a curtain.

Fron'ton. (*Architecture.*) The decorated entrance to a building consisting of a cornice supported by consoles and surmounted by a pediment.

Frost'ed. The dead or lusterless appearance of gold, silver, or glass, when polishing the surface is omitted. It is supposed to resemble the *hoar-frost*, and hence the name.

Frosted work is introduced as a foil or contrast to *burnish* work, in which the metal receives the full luster by an agate or flint burnisher.

Electro-plated work is in the frosted condition as it comes from the bath, and may be burnished in whole or in part.

The frosted appearance on glass is given by grinding, making *ground glass*, which diffuses the rays, and does not transmit a direct ray or a clear image.

Frost'ed-glass. (*Glass-manufacture.*) A form of glass formerly made by the Venetians, and recently revived by Apsley Pellatt, who thus describes it: —

"Frosted glass has irregularly varied marble-like projecting dislocations in the intervening fissures. Suddenly plunging hot glass into cold water produces crystalline convex fractures, with a polished exterior, like Derbyshire spar; but the concave intervening figures are caused, first by chilling, and then reheating at the furnace, and simultaneously expanding the reheated ball of glass by blowing, thus separating the crystals from each other, and leaving open figures between, which is done preparatory to forming vases or ornaments. Although it appears covered with fractures, it is perfectly sonorous."

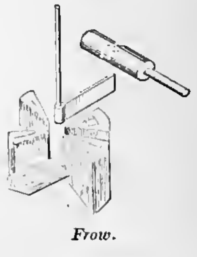
Frost-lamp. An oil-lamp placed beneath the oil-tube of an Argand lamp to keep the oil in a flowing condition on cold nights. Used especially in lighthouses.

Frost-nail. A roughing nail; driven into a horse's shoe in slippery weather.

Frow. (*Coopering.*) A cleaving tool for riving staves, shingles, or clapboards from the *balk* or *juggle*. *Frower, froe.*

It has a sharp edge, wedge-shaped blade, and a handle set in the plane of the blade, but at right angles to its length. It is driven by a mallet.

Fig. 2108.



Frow.

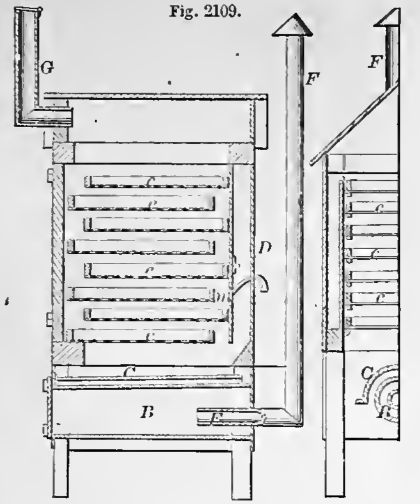
Frow'er. A Frow (which see).

Fruit-box. A small box of certain dimensions in which fruit is shipped to market. Berry-boxes are made of straw-board, scale-board, splints, and many other materials. Some of them are intended to be so cheap as to be sold with the fruit, others are frustums which pack in nests, others are collapsible for back shipment.

The larger fruits are carried in small crates, or open boxes made of slats.

Fruit-dry'er. A small house or kiln with furnace, shelves, and means for ventilation, used for drying fruits. There are many forms, which differ mainly in the arrangement of the parts named. In the example, the fire is made in furnace *B*, the heated surrounding air is deflected by plate *C*, passes in a

Fig. 2109.



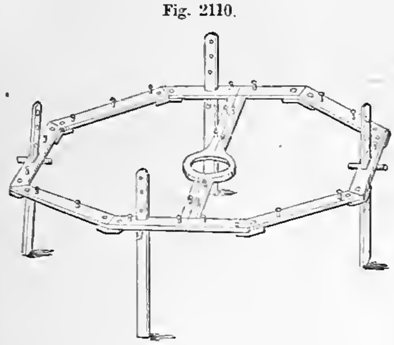
Fruit-Dryer.

sinuous course up among the shelves *c c*, and out at the duct *G*. The furnace *B* has its own flue *F*.

Fruit-frame. A trellis or espalier.

Fruit-gath'er-er. They are of two kinds. One in which a canvas is stretched beneath the tree to catch the fruit without bruising, as in Fig. 2110, which

Fig. 2110.



Fruit-Gatherer.

shows a jointed frame, over which a sheet is secured by the pins, the inner ring encircling the trunk.

Another form is really a fruit-picker, being on the end of a long staff, as in Fig. 2111, in which prongs

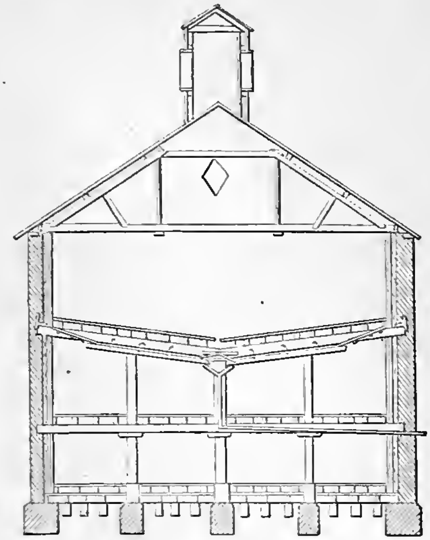
Fig. 2111.

Fruit-Picker.

hook off the fruit and a bag catches it. This latter kind has many varieties, with different modes of grasping or cutting, catching, and leading down the fruit.

Fruit-house. A storage house for fruit. The walls hove double thickness, with intervening non-

Fig. 2112.



Fruit-House.

conducting material, and provision is made for effective ventilation.

The walls and floors have wooden surfaces with non-conducting linings or blank spaces between all inner surfaces and the outer walls or the earth. Ventilating entrances are at the level of the ice-floor, with hatches opening down to the storage rooms, and inclosed spaces to carry off bad air through the mass of ice upward when it is light air, and downward out at the bottom of the entrance-doors when it is carbonic-acid gas, the light air passing through the upper space above the ice, and thence out at the windows of the observatory.

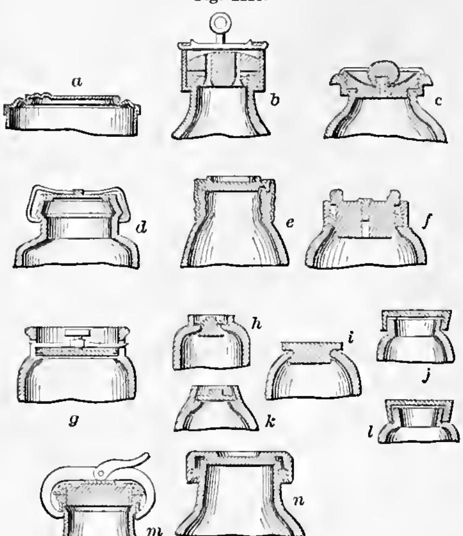
Fruit-jar. Jars for preserving fruit are made of earthenware or glass, especially the latter. Some have been made of metal with porcelain (so called) lining, but these have met with little favor, as the acids of the fruits attack the lead of the enamel and destroy it, and themselves become unwholesome. The same remarks apply to the earthenware, whose glazing has generally salts of lead, and is therefore unfit for the purpose. Some kinds of glass even, where lead has been used as a flux, are not entirely beyond suspicion. Glass jars were formerly blown, like bottles, but are now usually pressed and blown in molds. The exercise of ingenuity has principally concerned the modes of closing, to render them air-tight, protecting the contents from access of oxygen and consequent fermentation. Among the devices for this purpose are lids which screw down on the threaded neck of the jar, the edge of the lid coming against a caoutchouc gasket on a shoulder of the jar, or a gasket on the lip of the jar coming against the inner surface of the lid. Another favorite form is a flat or flanged lid pressed down upon a gasket on the lip by some mechanical locking contrivance.

In the illustration are shown several forms of fastening the lid hermetically to the jar, after filling the latter and driving out a small remainder of air by the steam of the heated contents.

a is a tin can with a lid whose flange dips into a trough on the can, which is closed by wax that is run into the trough.

b has a cover secured by hooks and a yoke, and pressed down upon a gasket on the lip. The holes in the lid are for the filling of any remaining space and the escape of the residual air. They are then both stopped.

Fig. 2113.



Fruit-Jars.

c has a cover secured by an elastic band which is held by lugs on the neck of the jar.

d has a cover secured by a yoke whose ends pass beneath inclined lugs on the neck so as to screw down the lid as the yoke is rotated.

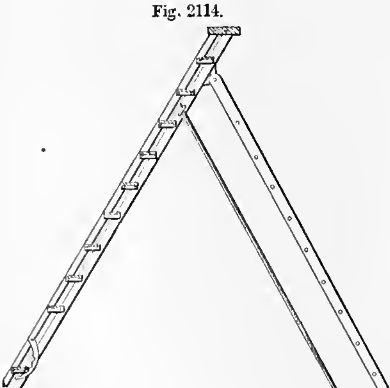
e has a glass lid, depressed by a sheet-metal screw collar, which engages the threaded neck of the jar.

f has a glass screw-stopper whose threads imbed themselves in the elastic gasket which is held in an interior groove of the neck.

g, a yoke fits in slots in the neck, and holds a center screw which presses the cover upon the gasket.

h i j k l are all forms in which an oval mouth admits the oval flange of the lid; the rotation of the latter brings the major diameter of the flange coincident with the minor axis of the opening, and locks the flange under the neck of the bottle.

Fig. 2114.



Fruit-Ladder.

m has a cover locked by a yoke and cam.

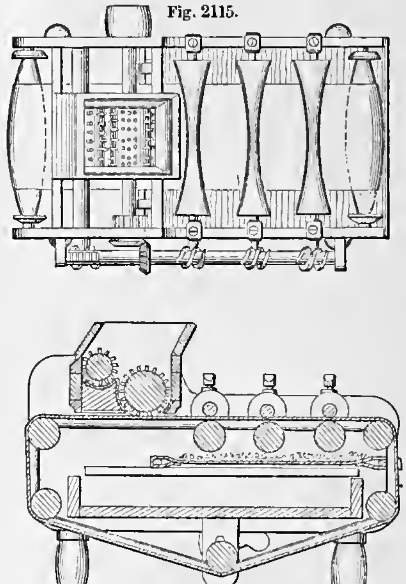
n has a grooved lid which holds the lip of the neck, and has a shoulder which fits against a gasket round the neck.

Fruit-knife. A knife for cutting fruit, having a blade which is not acted upon perceptibly by the acids of the fruit. Silver is the usual material.

Fruit-lad'der. A light ladder to rest against the limbs of the tree, or stand by itself while the picker stands upon it to gather fruit.

Fruit-mill. A mill for grinding grapes for must or apples for cider. (See CIDER-MILL.) The example shows a pair of studded grinding rollers, an apron

Fig. 2115.

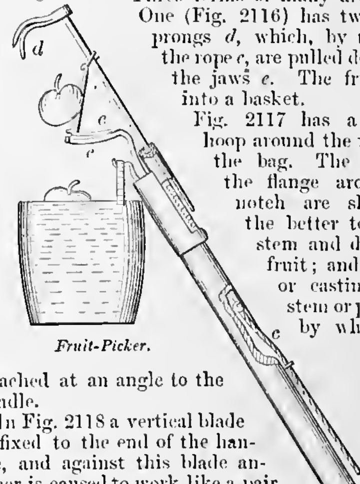


Fruit-Mill.

on to which the fruit falls and is carried between several consecutive pairs of rollers, which express the juice.

Fruit-pick'er. An implement for reaching up to and picking fruit from a tree. Three forms of many are shown. One (Fig. 2116) has two sliding prongs *d*, which, by means of the rope *c*, are pulled down upon the jaws *e*. The fruit drops into a basket.

Fig. 2116.



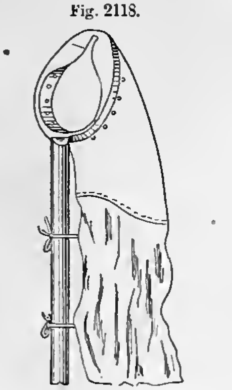
Fruit-Picker.

Fig. 2117 has a metallic hoop around the mouth of the bag. The edges of the flange around the notch are sharpened, the better to cut the stem and detach the fruit; and the band or casting has a stem or projection by which it is attached at an angle to the handle.

In Fig. 2118 a vertical blade is fixed to the end of the handle, and against this blade another is caused to work like a pair of shears, the movable blade being operated by a cord and spring. The stem of the fruit is cut, the fruit falling into a pocket attached to the top of the pole.

Fig. 2117.

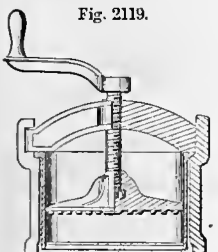
Fig. 2118.



Fruit-Pickers.

Fruit-press. One for expressing the juice of fruit. The subject is considered under CIDER-PRESS (which see). The example shows a small domestic press for fruit, such as those used in limited quantities for currant-wine, jellies, etc.

Fig. 2119.



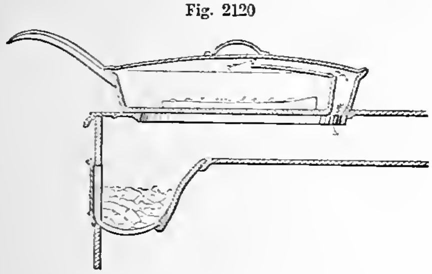
Fruit-Press.

Fry'ing-pan. A pan in which food is cooked in fat. In the illustration, a duct leads the fumes of the cooking down into the stove-flue.

Fudge-wheel. (*Shoemaking.*) A tool to ornament the edge of a sole.

Fu'el, Ar'ti-fi'cial. Agglomerated peat, sawdust, coal-dust, and slack, one or more of them in various combinations, bound together, by heavy pressure, with cements, clay, coal-tar, or the residuum of

Fig. 2120



Frying-Pan.

starch-manufacture. The latter is used in the Belgian and Austrian works. Dehaynin's works in Belgium turn out 175,000 tons of this fuel per year. It leaves six per cent of ashes. The Northern Railway of Austria has works which produce 15,000 tons per annum; prisms $9 \times 5 \times 4\frac{1}{2}$ inches, weighing eight pounds, evaporating seven pounds of water per pound of fuel. The coal is compressed with the refuse of starch-works as a cement, and dried in a kiln heated overhead by a current of hot air.

Small coal two parts and clay one part, molded into blocks like cannon-balls and dried, have been used for a century past in Hainault. — *London Monthly Magazine*, April 1, 1800.

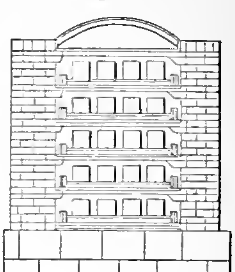
Peat and turf cut into blocks and dried have been used any time these thousands of years past, but the business of preparing peat-fuel by mechanical means and by admixtures is comparatively modern. (See PEAT-MACHINE.) In 1603 Sir Hugh Platt published a book in which he described a new fuel block made of coal and loam in "the manner of Lukeland of Germanie." He also used coal-slack, sawdust, tanner's bark, aggregated by loam and cow-dung. Chabanne's English patent of 1799 claimed separating the large coal from the small coal by passing the latter through sieves or gratings made of wood or metal, and then consolidating the small coal by mixing it with earth, clay, cow-dung, tar, pitch, broken glass, sulphur, sawdust, oil-cakes, tan, or wood, or any other combustible ingredient, to be mixed together and ground with a wheel in water, in a wooden vessel; this mixture he afterwards placed in pits provided with drains for the water to run off, and then, when dry, molded the mass into cakes of a considerable size.

The following United States patents may be consulted: —

13,056	1855.	44,262	1864.
15,688	1856.	44,940	1864.
26,541	1859.	47,296	1865.
35,472	1862.	50,588	1865.
40,753	1863.	51,833	1866.
40,791	1863.	53,431	1866.
40,920	1863.	55,369	1866.
42,163	1864.	61,006	1867.
43,112	1864.		

Fuel-dry'er. A kiln for drying blocks of artificial fuel. The trays supporting the blocks of fuel run upon rollers upon the angle-iron bars secured in the walls. The walls have perforations to allow the escape of the vapors resulting from the drying of the blocks. Either heated air or steam-pipes may be placed between the trays. The ends of the chamber may be closed by metallic doors.

Fig 2121.



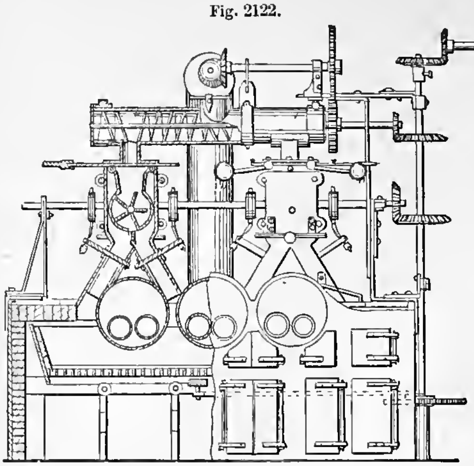
Fuel-Dryer.

Fu'el-feed'er. A device for feeding fuel in graduated quantities to a furnace, either for metallurgical purposes or for steam-boilers. The example shows an apparatus for carrying coal, sawdust, and other fuel, from a bunker to the furnace, and feeding it regularly and evenly upon the grate under the boilers. It is worked by the engine. It will be readily understood without specific description. James Watt, 1769, and some even before him, tried to feed furnaces mechanically to save fuel. Some of the devices are noted under SMOKE-CONSUMING FURNACE (which see).

Fu'el Press, Com-pressed'. A machine for compressing coal-dust and a cementing material into a block.

In one form the material is forced within cylindri-

Fig. 2122.



Fuel-Feeder for Steam-Boiler Furnace.

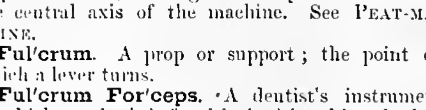
cal pipes of cast-iron by the resistance offered to its passage through the pipe, and caused by the friction of the material against the sides of the pipe. The compressed fuel passes out of these cast-iron pipes, as a continuous cylindrical bar, which is broken in suitable lengths, and sold in the form of round logs.

Mazeline's machine produces bricks of prismatic form. It consists of a mixing apparatus, which feeds the material into a machine, having twelve square molds arranged in a circular frame, which has a rotating movement. Each die is worked by a square piston projecting into it from the bottom, and acted upon by an inclined plane which presses the pistons upward during the revolution of the circular frame, so that each brick is completed and delivered by the respective mold, making one complete turn round the central axis of the machine. See PEAT-MACHINE.

Ful'crum. A prop or support; the point on which a lever turns.

Ful'crum For'ceps. A dentist's instrument in which one beak is furnished with a hinged plate

Fig. 2123.



Fulcrum-Forceps.

which bears against one side of the object, while the other beak has the usual tooth or gouge shape.

The plate is covered with an india-rubber pad or cushion about ⅛ of an inch thick, secured by fine wire. The pad rests on the gum.

Ful'gu-ra'tion. (*Metallurgy.*) The sudden brightening of gold or silver in the crucible as the last traces of dross leave the surface.

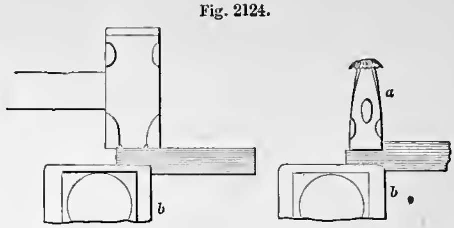
Full-bound. (*Bookbinding.*) Covered with leather.

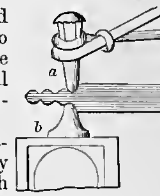
Full-cen'ter Arch. A semicircular arch or vault. One describing the full amount of 180°.

Full'er. (*Forging.*) 1. A tool, sometimes known as a *creaser*, struck by the hammer or placed in the hardy hole of the anvil and employed to swage down or spread the iron by a series of parallel indentations.

The tools are known respectively as the *top* (*a*) and *bottom fuller* (*b*).

Fig. 2124.





Fulling-Tools.

2. A tool having grooves, and forming a die or swage into which iron is driven by the hammer to confer a shape. Used in forming the fullering of horseshoes.

Full'er's-earth. An unctuous, aluminous earth used by fullers to absorb the oil with which wool has been treated in a previous part of its manufacture.

Full'ing. A process by which cloth made of a felting fiber is condensed, strengthened, and thickened, with a loss of width and length. Some fibers will felt, others will not. (See FELT.) In felting, the fibers — wool, for instance — slip past each other, and their toothed edges interlock, so that a continuation of the process causes them to be more and more intimately associated, huddling together and holding tight.

The cloth is folded or rolled, and treated with soapy water. It is then beaten with wooden stocks or mallets, by which the serrated edges are forced past each other and the fibers closely commingled. Precautions are taken in some cases to prevent adherence of the folds of cloth by felting together. For this purpose cotton cloth may intervene between the folds of woolen cloth in the roll. It is usually folded, however.

Fulling and felting are dependent upon the same principle of action. Felted cloth is made by this process of associating the fibers, and is not woven. Woven cloth exposed to the fulling or felting action is said to be *milled.* Repetition of the process constitutes it *double-milled* or *treble-milled*, as the case may be. Each milling thickens and solidifies it, while diminishing the area.

In a tomb at Beni Hassan about the time of Osirtasen, who was probably the Pharoah that invited Jacob to Egypt and settled him in Goshen, we find a representation of the fulling process (shown at *a*, Fig. 2125). The roll of cloth is wetted and worked between a block and the inclined table, the water running into a trough below.

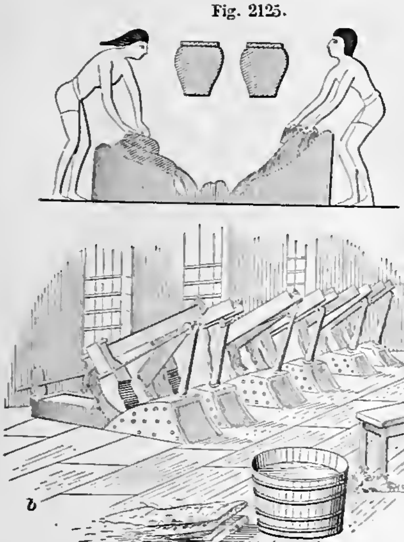
After this record of the eighteenth century B. C., it is easy to discredit the statement of Pliny that the art of scouring and fulling cloth and woolen stuffs was invented by Nicras, the son of Hermias, who was a governor of Megæra under Augustus. The Romans worked the cloth with lye and fuller's earth, then washed it in a decoction of saponaceous plants, and then bleached it by fumigation with sulphur.

The instruments of the fuller are mentioned by the Greek authors. One form is a pounder, and the other a wooden roller.

The operations of fulling are shown in the paintings on the walls of Pompeii. At that time the fullers were also the washers of ordinary clothes.

"The largest and best executed paintings representative of the art were discovered in 1820, in the house of a fuller opening on one side on the street of Mercury, and on the other on a street called after him, Fullonica. In the court, a pillar covered with pictures was standing alongside a fountain. This pillar has been removed and deposited in the Naples Museum. In the lowest division, a woman, sitting, hands a piece of cloth to a little female slave. A workman, whose tunic is closely tied around the body, is looking at them while at the same time carding a white cloak with a purple border, suspended from a stick. Another workman is in the act of sitting down alongside a crate of wicker-work on which the cloth is to be spread out; in one hand he holds a vase, on which sulphur thrown on burning charcoal will develop a gas capable of bleaching the cloth. This is the same method which is used to-day. On another face of the pillar arched niches contain large vats where the goods are soaked. Slaves standing in those vats trample the fabric with their bare feet in the same manner as Arabian women wash their clothes by trampling them against the rocky bed of a stream; this is what the ancients called "the fuller's dance" (*saltus fullonicus*). The artist has painted with the same care the press with its two uprights, its two enormous screws, which were turned by means

Fig. 2125.



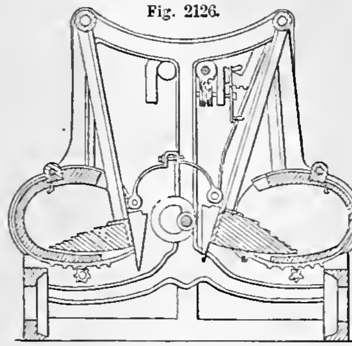
Fulling-Mill.

of cranks, in order to flatten the cloth beneath the planks, which imparted the necessary finish. Finally, the drying-chamber is shown by long sticks hanging on chains from the ceiling. The linen is spread out on them; a slave hands to a young woman an open fabric, while the wife of the fuller makes a note of it on her tablets. I have visited with particular curiosity the houses in Pompeii where these pictures had been gathered. I counted there in a court twenty-two tanks constructed of stone, and at different levels, so that the water could run from one into the other. Little benches in front of them served for the reception of the goods. At the other end of the court, seven smaller tanks served for fulling. The store-room, with traces of the planks, which were laid like rays radiating from a center, the hearths, the drying-chamber, may still be recognized. In other fullers' establishments I have seen very thick sheet-lead lining the interior of vats made of cement. Sometimes, also, we find jars full of greasy earth, which must be the fuller's earth of which Pliny speaks, and which contributed as much to the whiteness of the goods as the fumigation with sulphur." — M. Beulé.

The modern fulling-mill *b* consists of an iron framework supporting the shanks of heavy wooden mallets, which are raised by projecting cams on a tappet wheel. The mallets being raised to their full hight are released, and drop by gravity on the cloth, which is contained in an iron trough beneath. Soap is added as a detergent, grease in any form tending to mar the felting action of the fibers. The end of the trough is curved, so that the cloth is turned round and round by the action of the mallets.

Fig. 2126 is a vertical section of a double mill in which a spring or weight forces the tub up to the

Fig. 2126.

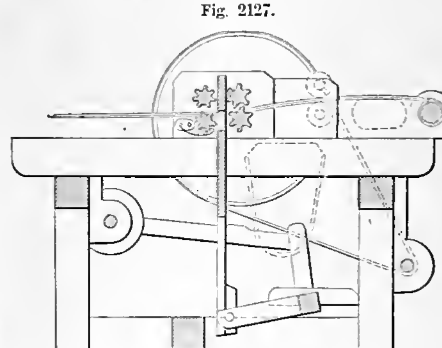


Double Fulling-Machine.

beaters with a yielding pressure, rendering the tub capable of adjusting itself to a larger or smaller quantity of goods. The beaters are arranged in pairs, each pair being connected together by springs and acted upon by a common eccentric.

In Fig. 2127 the felted cloth is held slack between two pairs of fluted rollers while a beater operates upon it. The variation in the velocity of the respective pairs of rollers is equal to the contraction of the cloth, which is damped and dried at the

Fig. 2127.

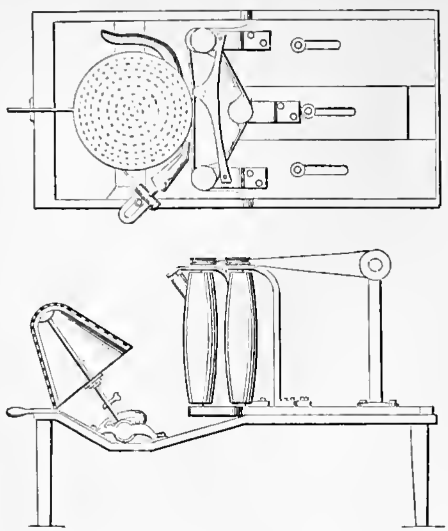


Roller Fulling-Machine.

commencement and close, respectively, of the operation.

Fig. 2128 shows a machine for fulling and felting hat bodies, in which the rollers carry around the apron, which, by contact, rotates the "form," and acts upon every portion of the perimeter of the hat body, the latter being saturated with water, which may be conducted through the tubular support of the form, and be diffused between the walls of the form, so as to escape outward. Owing to the eccentricity of one of the rollers, the apron is repeatedly stretched and relaxed, laterally, and in the act of

Fig. 2128.



Hat Fulling-Machine.

drawing narrower the apron produces a greater pressure upon the hat body, and has the effect to interlock and compact the fibers.

A *broad-cloth* having 3,600 threads in the warp, a width of $3\frac{3}{16}$ yards, and a length of 54 yards, will be reduced in fulling to $1\frac{3}{4}$ yards wide and 40 feet long. The process will take 60 to 65 hours, and require 11 pounds of soap.

A *Venetian* cloth will require about twelve hours, take from 6 to 7 pounds of soap, and will shrink in width from $1\frac{15}{16}$ yards wide to $1\frac{9}{16}$.

After fulling, the cloth is washed to remove the soap.

The method of fulling woolen goods in early times in Ohio is well described by Judge Johnston of Cincinnati, in his address before the Pioneer Society of that city, 1870.

KICKING BLANKETS.

"When wool became abundant, the method of scouring and fulling blankets, flannels, cassinets, and even cloths, was simple. Every house had hand-cards, and as many spinning-wheels as spinners, and no respectable house was without a loom. When the goods were carded, spun, and woven, then came the kicking frolic. Half a dozen young men, and a corresponding number of young women, "to make the balance true," were invited. The floor was cleared for action, and in the middle was a circle of six stout splint-bottomed chairs, connected by a cord to prevent recoil. On these sat six young men with shoes and stockings off and trousers rolled up above the knee. In the center the goods were placed, wetted with warm soapsuds, and then the kicking commenced by measured steps, driving the bundle of goods round and round; the elderly lady, with a long-necked gourd, pouring on more soapsuds, and every now and then, with spectacles on nose and yardstick in hand, measuring the goods till they were shrunk to the desired width, and then calling the young men to a dead halt.

"Then while the lads put on their hose and shoes, the lasses stript their arms above the elbows, rinsed and wrung out the blanket and flannels, and hung them on the garden fence to dry."

Full'ing-ma-chine'. A machine in which the operation of fulling cloth is performed. See FULLING.

Full'ing-mill. A common name for the fulling-machine. See FULLING.

Ful'mi-nate. Beckman states that fulminate of gold was discovered by a monk in the fifteenth century. This substance, which explodes more rapidly and with greater local force than gunpowder, is made by precipitating a solution of chloride of gold by an excess of ammonia. Mr. Forsyth discovered that by treating mercury as the old monk had treated gold, an equally powerful but far less expensive fulminate might be made. This he mixed with six times its weight of niter, and the result is the percussion-powder which, in the form of paste, is used for charging copper caps for fire-arms. In modern practice the proportion of niter has been much reduced.

"Dr. Allen tells me that something made of gold, which they call in chymistry *Aurum Fulminans*, a grain, I think he said, of it, put into a silver spoon and fired, will give a blow like a musquett, and strike a hole through the silver spoon." — PEPYS, 1663.

A fulminating powder which explodes when heated to 360° may be made of niter, 3 parts; dry carbonate of potash, 2 parts; sulphur, 1 part.

The following patents may be consulted by those desirous of ascertaining the ingredients of various patented fulminates: —

Guthrie	1834.	Boldt	1866.
Kling	1857.	Rand	1867.
Ruschaupt *et al.*	1862.	Goldmark	1867.
Lipps	1864.	Ruschaupt	1868.
Stockwell	1865.		

Fu'mi-ga'tor. An apparatus for applying smoke, gas, or perfume: —

1. To destroy insects or vermin in their holes, or upon clothing, trees, or plants.
2. To destroy infection or miasma in buildings, ships, clothing, or feathers.
3. To diffuse a fragrant or invigorating perfume through an apartment or ward.
4. To suffuse the lungs with a soothing or healing vapor.

The fumigator involves the use of heat, and generally that of an artificial blast.

1. A fumigator for expelling or killing animals usually consists of a chamber in which burning matters are placed, and a bellows by which a blast of air is driven through the retort, issuing with the fumes at a nozzle directed to the burrow or haunts of the vermin.

Sometimes powder is substituted for fumes.

2. Fumigators for destroying infection are sometimes only agents for making a stench which overpowers the precedent nuisance. The burning of tobacco, feathers, leather, brown paper, etc., will conceal, but does not remove, an unwholesome smell. More potent agents, such as pastiles, pepper, hot vinegar, etc., have been used as disinfectants with but small effect.

The effective agents in fumigating are sulphurous acid gas, chlorine, tar, roasting coffee, etc.

The ordinary disinfectant is chlorine, either in the form of chloride of lime or in the direct evolution of gas from a mixture of salt, manganese, suphuric acid, and water.

This was the plan adopted by Faraday in the disinfecting of a penitentiary in London. The space being about 2,000,000 cubic feet, he used 700 pounds of common salt and the same quantity of black oxide of manganese. The mixture was set about in numerous pans throughout the wards and corridors. Three and a half pounds of a mixture of salt and manganese were placed in a pan, and on them was poured 4½ pounds of dilute acid. (Sulphuric acid, 2; water, 1.)

3. The perfuming fumigator is generally of the form of an ATOMIZER (which see).

4. As applied to the mouth it is an INHALER (which see).

Fum'ing-box. (*Photography.*) In printing photographically, the sensitive paper, having chloride and nitrate of silver upon its surface, is exposed to the fumes of ammonia immediately before its exposure to light under the negative; the object being to secure greater depth and brilliancy in the resulting print. The apparatus for this purpose is simply a tight box, in which the sensitive sheets can hang, leaving a space below them for a flat basin containing ammonia. Boxes of this kind are variously constructed, the object in all cases being to admit of the ready introduction and removal of the sheets, as well as of the vessel containing ammonia, without subjecting the operator to unnecessary annoyance from the fumes.

Fu-nic'u-lar-ma-chine'. One actuated by means of a cord whose ends are attached to two objects and which bears a weight suspended from the bight. Some double-toggle presses come within the terms of this description. The name is principally applied to instruments illustrative of mechanical principles, and having a rope, pulley, and suspended weights.

Fun'nel. 1. The chimney of a steamship. It is of sheet-iron, and is carried to a sufficient hight to assist the draft of the furnace.

It is made telescopic in war-vessels, so as to be lowered beyond the reach of shot.

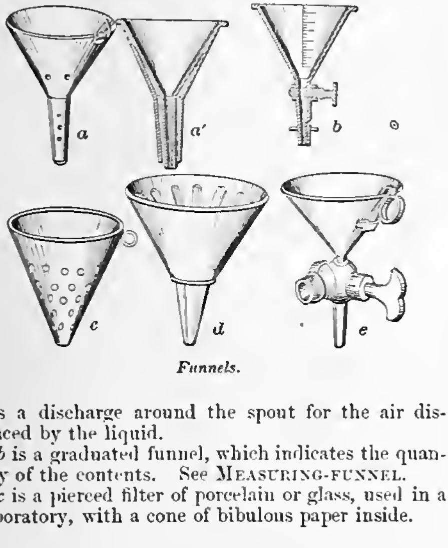
2. The pouring-hole of a mold. A *gate*; a *tedge*.

3. A conical vessel which terminates below in a spout, and used for conducting a liquid into a vessel which has a small opening.

An implement with a wide mouth and tapering spout, used for conducting liquids into a narrow-throated vessel.

a a' are elevations and sections of a funnel, which

Fig 2129.



Funnels.

has a discharge around the spout for the air displaced by the liquid.

b is a graduated funnel, which indicates the quantity of the contents. See MEASURING-FUNNEL.

c is a pierced filter of porcelain or glass, used in a laboratory, with a cone of bibulous paper inside.

d is a filter of similar use, but with heavy ridges, to keep the paper from adhering to the sides.

e is a combined measure, faucet, and funnel.

The filter-funnel should have sides which subtend an angle of 60°, for the reason that a sheet of bibulous paper, folded quarterly and one flap opened, forms a cone the vertical section of which is a triangle with sides forming that angle.

Fun'ny. (*Nautical.*) A narrow, clinker-built pleasure-boat, to be rowed by a pair of sculls.

Fuor. (*Carpentry.*) A piece nailed upon a rafter to strengthen it when decayed.

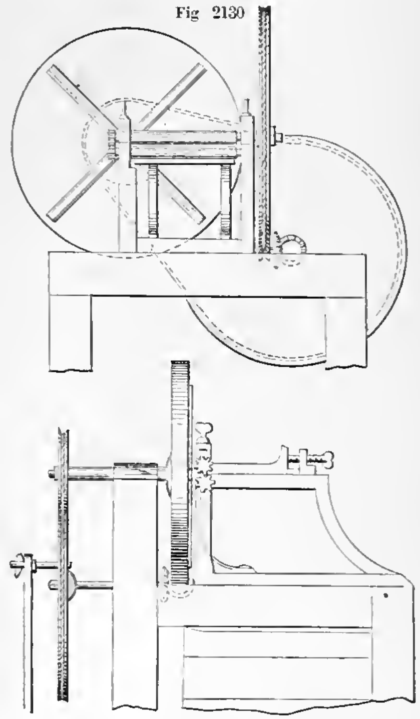
Fur'bish-er. A *burnisher.*

Fur-cut'ter. 1. A machine for cutting the fur from the skin.

Johnson, 1837, has a knife hinged at the end, and descending to make a shear cut against a stationary blade. The skin passes over a small roller, which displays the fur and enables the knife to reach the hairs near the roots, without to any great extent cutting to waste or cutting the same hairs twice.

Petre, 1827, has a pair of rollers, between which the skin passes. As the skin is bent over one of the rollers, the hairs are displayed and thus laid over a straight edge. The knives are fixed radially to a rotating disk, and shear past the straight-edge, sev-

Fig 2130



Petre's Fur-Cutter.

ering the hairs with nearness to the skin determined by the *set* of the machine.

Williams, 1832, has a frame with a series of parallel knife-edges presented upwardly. Over them is a block carrying an oblique knife which makes a shear cut upon the fixed knives in succession.

Flint's fur-cutting knife, 1837, has an edge on one jaw and a cushion on the other.

See also Harlow's patent for cutting bristles, 1868.

2. A mechanical contrivance for shaving the backs

of peltry skins, to loosen the long, deeply rooted hairs, leaving the fine fur undisturbed.

Fur-dress'ing. Fur, in its usual trade acceptation, is the short, fine hair of certain animals, growing thick on the skin and deprived of the long, coarse, protecting hairs.

Furs are dressed by greasing and tramping, or by beating in a fulling-mill, the skin being softened by the absorption of grease and the mechanical treatment. They are then wetted, fleshed, curried, tramped in vats with sawdust, and again with whitening to remove the grease. They are then beaten with a stick and combed.

The term *dressing* includes the cleaning, cutting, and dyeing of furs. The long hair that covers the fur is removed by a process carried on in but few places successfully. The skins are placed on frames, and the inner surface pared off, until the roots of the *hair* are completely severed, while the roots of the *fur* remain untouched, on account of their nearness to the outside surface. The hair is then very easily removed, and the light yellow fur made ready for dyeing, either to a more golden yellow, a dark purple, or black, and is afterwards brought to the general fur-market.

In one process, the hair and skin are separated and a substitute for the skin applied to roots of the hair to retain them. Gelatine is applied in solution to the hair, so as to form, when cool, a body to hold the hair in position during the removal of the natural skin and the application of a substitute to the roots. The hair and natural skin are loosened by soaking in lime-water or other suitable means. The artificial skin may be formed of india-rubber, gutta-percha, or compounds thereof, boiled or drying oil, or other adhesive matters, strengthened, if desired, by woven fabrics, and when applied and set, the glutinous matter employed as temporary holding medium may be removed by dissolving in warm water or steam.

Furl. (*Nautical.*) To roll a sail and confine it to the yard.

The sail being gathered by the men on the yard, the *leech* is passed along the yard to the *bunt*, where the body of the sail, the *foot* and *clews*, are collected.

Cunningham's patent (English) mode of setting and furling sails is, by rolling the yard by means of ropes from the deck, unwinding or winding the sail, as the case may be. The plan involves a vertical division of the sail, and has not come into general use.

Furl'ing. The wrapping or rolling of a sail on a yard or boom and securing it.

Fur'nace. A chamber in which fuel is burned for the production of heat, which is directed upon an object in the vicinity, such as an ore or metal under treatment, a steam-boiler, an air-heating chamber, a glass-pot, or what not.

Furnaces are distinguished by construction, by mode of operation, and by purpose. See under the following heads: —

Air-furnace.
Air-heating furnace.
Almond-furnace.
Aludel-furnace.
Annealing-arch.
Annealing-furnace.
Antimony-furnace.
Arsenic-furnace.
Ash-furnace.
Asphaltum-furnace.
Assay-furnace.
Athanor.
Balling-furnace.
Bar-heating furnace.
Bath-furnace.
Bead-furnace.
Biscayan-forge.
Bismuth-furnace.
Blast-furnace.
Blomary-furnace.
Blowing-furnace.
Boiler-furnace.
Boiling-furnace.
Bone-black furnace.
Bottoming-hole.
Brass-furnace.
Brick-kiln.
Burning-house.
Calcar.
Calcining-furnace.
Carbonizing-furnace.
Carquaise.
Car-wheel furnace.
Castilian-furnace.
Cast-steel furnace.
Catalan-furnace.
Cementing-furnace.
Chaffer.
Charcoal-furnace.
Charcoal-kiln.
Chaufer.
Chemical-furnace.
Coke-furnace.
Coke-oven.
Converting-furnace.
Copper-furnace.
Cupello.
Cupola-furnace.
Decarbonizing-furnace.
Dental-furnace.
Desulphurizing-furnace.
Draw-kiln.
Dumb-furnace.
Dust-fuel furnace.
Enameling-furnace.
Enamel-kiln.
Engine-furnace.
Evaporating-furnace.
Finery-furnace.
Fire-back.
Fire-bar.
Fire-door.
Flashing-furnace.
Flatting-furnace.
Foge.
Forge.
Fritting-furnace.
Fruit-dryer.
Fuel-feeder.
Gallery-furnace.
Gas-furnace.
Gas-heated furnace.
Gas-reverberatory furnace.
Glass-furnace.
Glass-annealing furnace.
Glaze-kiln.
Glory-hole.
Glost-oven.
Gold or silver furnace.
Grain-dryer.
Gypsum-furnace.
Hardening-kiln.
Haymaking-furnace.
Heating-furnace.
Hot-air furnace.
Hot-blast furnace.
Hydro-carbon furnace.
Iron-furnace.
Kiln.
Kiln-dryer.
Lamp-black furnace.
Lead-furnace.
Leer.
Lime-kiln.
Liquidation-furnace.
Liquid-carbon furnace.
Locomotive-furnace.
Lumber-kiln.
Malleable-iron furnace.
Malt-kiln.
Mercury-furnace.
Muffle-furnace.
Nitric-acid furnace.
Nose-hole.
Oast.
Ore-calcining furnace.
Ore-roasting furnace.
Ore-smelting furnace.
Oven.
Oxidizing-furnace.
Peat-burning furnace.
Petroleum-furnace.
Portable-furnace.
Pottery-kiln.
Puddling-furnace.
Quicksilver-furnace.
Reducing-furnace.
Refining-furnace.
Regenerating-furnace.
Reheating-furnace.
Reverberating-furnace.
Riveting-hearth.
Roasting-furnace.
Salt-furnace.
Silver-furnace.
Slag-furnace.
Slip-kiln.
Smelting-furnace.
Smoke-consuming furnace.
Soldering-furnace.
Spreading-furnace.
Steam-boiler furnace.
Steel-furnace.
Stück-furnace.
Sugar-furnace.
Sulphur-furnace.
Sweating-furnace.
Test-furnace.
Tile-kiln.
Tin-furnace.
Upsetting-furnace.
Vulcanizer.
Welding-furnace.
Wind-furnace.
Wrought-iron furnace.
Zinc-furnace.

Fur'nace-bridge. A barrier of fire-bricks or of iron plates containing water thrown across the furnace at the extreme end of the fire-bars, to prevent the fuel being carried into the flues, and to quicken the draft by contracting the area.

Fur'nace-grate. The bars supporting the fuel in a furnace. See GRATE.

Fur'nace-hoist. An elevator for raising the ore, lime, and coal to the mouth of a blast-furnace. These are of several different forms; the example shown is on the pneumatic principle. It consists of a central tube *a* in which is a heavy piston *b*, which forms a counterweight for the platform *c*, which works against guides on the outside of the tube. The piston is lightly packed by cotton gaskets, and is connected to the platform by four wire-ropes, two of which only appear in the vertical sectional view.

The hoist is worked by an engine with a pair of inclined cylinders, operating a pair of single-acting air-pumps, which can be made to compress air into or exhaust air from the space in the tube below the piston. Supposing the empty table with the empty barrows to be at the top, and the piston at the bottom of the cylinder, the air-pumps are connected with the latter so as to deliver air into it, and thus lift the piston, a pressure of about two pounds per square inch being sufficient to do this. On the other hand, if the table is at the bottom of its travel and loaded, the exhausting side of the air-pump is, by means of the reversing slide, placed in communication with the cylinder, and a partial vacuum produced under the piston. If the table be loaded with the heavy iron-stone wagons, carrying about 5,000 pounds of stone, there is a weight of about 4,000 pounds left unbalanced, and exhaustion of about 4 pounds per square inch is required to bring the piston down, while, with the coke-barrows, weighing only 2,000 pounds, there is but about 1,000 pounds of unbalanced load, and the piston is brought down and the table raised by a vacuum of about one pound only.

Fur'ni-ture. 1. (*Nautical.*) The masts and rigging of a ship.

2. The mountings of a gun.

3. Builders' hardware, such as locks, door and window trimmings, etc.

4. Movable articles of use and decoration in a house.

The ancient Egyptians excelled in furniture, chairs with arms and backs magnificently upholstered, with seats like our rush-bottoms, or folding like our camp-stools.

Their bedsteads were couches, generally designed for one person, and variously ornamented. Some have legs representing those of men or of dogs, the bed portion being a ridiculously attenuated body to correspond. See CHAIR; BEDSTEAD, etc.

Their tables were round, square, oblong; of wood, stone, metal; carved, painted, gilded; with a central column or with several legs.

5. (*Printing.*) The wooden inclosing strips and *quoins* which surround the *matter* in the *chase*.

The pieces are about half an inch high, of various lengths. The strips are called *head*, *foot*, or *side sticks*, according to their position in the *chase*.

Strips between the pages are *gutters*.

The *sticks* are slightly tapering, so as to allow the wedge-shaped *quoins* to jam the matter firmly together in the *chase*.

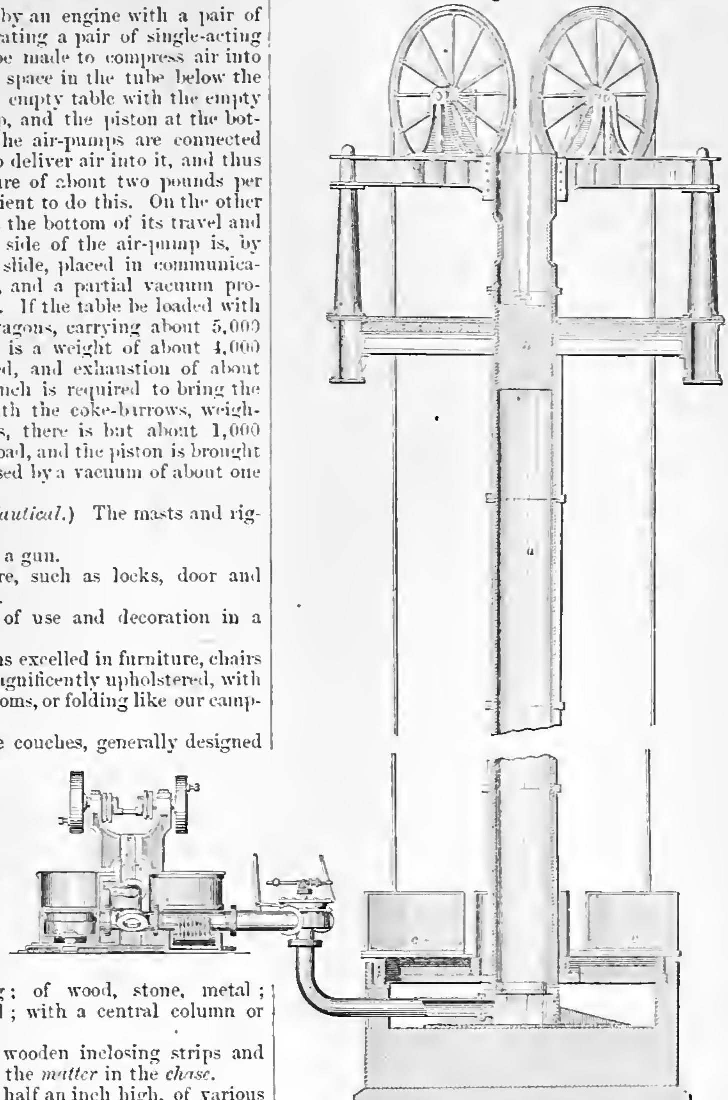
The *quoins* are driven by the *shooting-stick* and a mallet.

Fur'ni-ture-pad. A piece of india-rubber or similar thing attached to a piece of furniture to prevent rubbing or striking against objects.

Fur'ni-ture-spring. A coiled spring beneath the hair filling which forms the seat, back, or side of a cushioned chair. A spring of a bed-bottom beneath a mattress, or forming the lower portion of one beneath the elastic material which constitutes the top.

Fur'ni-ture-tip. An india-rubber disk placed on the foot of a chair-leg, to enable the chair to be

Fig. 2131.



Furnace-Hoist.

moved and replaced noiselessly upon bare boards or marble floors.

Fur-pull'er. The fine fur of fur-bearing animals is protected by a coat of long, straight hairs, which is removed before the fine hair is sheared off to furnish the material for felt.

This operation, formerly effected by hand, is now performed by machines. The skin is passed around the projecting edge of a bed, the tension of the skin being maintained by weights. As the skin is drawn forward over the projecting edge of the bed, the long hairs stand out nearly at right angles, and are seized and extracted by ribs on a pair of revolving cylinders which are placed in front of the bed.

Graham's machine, 1835, passes the skin between two feed-rollers over a third higher roller, which spreads the hairs, which are pinched between a revolving blade and the elastic surface of a leather-covered cylinder, and so pulled out of the skin, which is stretched and fed by two pairs of rollers between which it passes.

Fur'ring. 1. Fixed thin pieces on the edge of timber to make the surface even.

2. Double planking of a ship's side.

3. The scaly deposit on the inside of a boiler.

4. A lining of scantling and plaster-work on a brick wall, to prevent the dampness of the latter reaching the room.

Fur'row. 1. (*Agriculture.*) The trench made by a plow.

2. (*Milling.*) The grooves in the face of a mill-stone; the plane surface is *land.*

A *leader-furrow* extends from the eye to the skirt of the stone at such *draft* as may be determined. The draft is the degree of deflection from a radial direction. In a seven-inch draft the track edges are tangential to a seven-inch circle around the eye of the stone. The steep edge of the furrow is called the *track*-edge; the more inclined edge is called the *feather*-edge.

The *second furrow* is that branching from the leader nearest to the eye.

The *skirt-furrow* departs from the leader nearer to the skirt.

A *gouge-furrow* is concave at bottom. See MILL-STONE.

Fur'row-ing-ham'mer. A mill-stone dresser's hammer. See MILL-STONE HAMMER.

Fur'row-ing-plow. One with a double mold-board for throwing the earth both ways.

Fu'sa-role. (*Architecture.*) A molding or ornament placed immediately under the echinus in the Doric, Ionic, and composite capitals.

Fuse. A tube or casing filled with combustible material, and used for igniting a charge in a mine or hollow projectile.

The invention was undoubtedly contemporaneous with that of hollow projectiles.

Blasting-fuse; used in mining and quarrying is filled with a slow-burning composition, allowing time for the operatives to reach a place of safety before it burns down to the charge.

Combination-fuse; for hollow projectiles, comprises a time-fuse and a percussion or concussion-fuse united in the same case.

The former is designed to explode the charge in case the latter fails to act on striking.

Concussion-fuse; for hollow projectiles. Designed to explode the charge when the shell strikes an object.

Electric-fuse. One adapted to be ignited by the passage of an electric spark through it.

Percussion-fuse; embraces a capsule charged with fulminate, which is exploded by a plunger or its equivalent, when the projectile strikes. The plunger is held by a pin sufficiently strong to keep it in place in case of a fall, yet weak enough to be severed by the shock of striking.

Safety-fuse; a cord or ribbon-shaped fuse filled with a fulminating or quick-burning composition, and sufficiently long to be ignited at a safe distance from the chamber where the charge is placed.

Tape-fuse; belongs to the class just mentioned, and is so called from its shape.

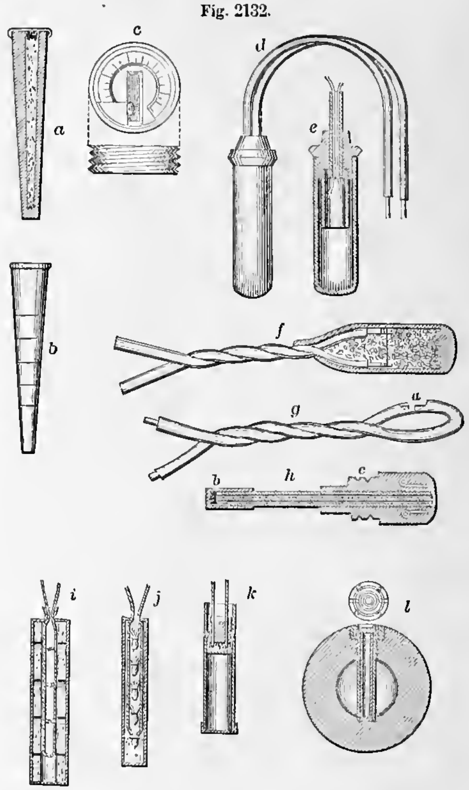
Time-fuse; one which is adapted either by cutting off a portion of its length or by the character of its composition to burn a certain definite time.

Fig. 2132, *a b* is the common wooden fuse for shells; the central cavity is filled with a composition of niter sulphur and mealed powder thoroughly incorporated together, and uniformly and compactly driven by means of a mallet and drift. The open end is capped with water-proof paper or parchment.

For use, a part is sawed off at the smaller end. The number of seconds which the remaining composition will burn is indicated by the annular lines, so that cutting off a greater or less portion regulates the time of bursting of the shell. The fuse is inserted in the fuse-hole when the projectile is required for use, and the cap removed previous to loading the piece.

Paper fuses containing compositions which burned at the rate of two, three, four, and five seconds to

Fig. 2132.



Fuses.

the inch were formerly employed for field artillery in the United States service. A wooden fuse-plug was driven into the projectile when prepared for service, and the fuse inserted therein at the moment of loading. The different kinds were indicated by their color.

These were succeeded by the Bormann fuse *c*, which consists of a flat, circular, screw-threaded piece of an alloy composed of equal parts of tin and lead, having a deep annular channel extending nearly around its lower surface, into which the fuse composition is pressed, communicating with a magazine of fine powder. The composition is protected by an annular piece of the same metal, which is forced down over it by pressure, and turned to a smooth surface. The upper part of the fuse is graduated to quarter-seconds up to five seconds, so that by removing the thin metal covering with a small gouge at any particular mark, the composition, when ignited, will burn the length of time that the mark indicates before reaching the magazine which communicates fire to the bursting charge of the projectile. This fuse rests in part on the walls of the shell and in part on a perforated iron fuse-plug, set in a smaller orifice central to the exterior fuse-hole. When screwed in, it is cemented to the shell by white lead ground in oil, rendering its extraction somewhat difficult and dangerous. To obviate this a modification has been contrived consisting of a flat ring which contains the composition inserted into an annular groove surrounding the hole through which powder is poured into the shell. As this may be made smaller than the ordinary fuse-hole, the efficacy of the bursting charge for shattering the shell is increased, while the charge may be removed without disturbing the fuse; thus greatly lessening the danger of accidents, when it is desired to remove the powder. This form also admits of longer burning fuses than the original Bormann.

Brass fuses having a crooked channel to prevent the entrance of water between the exterior priming and the fuse composition are also employed, more particularly in the naval service.

The English Boxer fuse has a main channel for the fuse-composition, and two smaller channels filled with mealed powder communicating therewith and with each other. Holes corresponding to the lengths required to burn various times are bored from the exterior of the fuse-case to these, and filled with pipe-clay, which is removed from the proper hole when the projectile is inserted into the gun.

Powel's fuse *l* (Fig. 2132) admits of being turned within the plug, which is screwed into the shell so as to bring corresponding apertures in the fuse and the plug into communication. These are so adjusted to each other that the composition may be made to fire the bursting charge at the expiration of a greater or less number of seconds.

Fuses on this principle have been combined with the percussion-fuse, constituting the *combination* fuse.

Previous to the introduction of rifled cannon and elongated projectiles, a number of attempts had been made to produce a fuse adapted to spherical projectiles which would explode on striking.

One of these, of Prussian origin, was composed of a glass case containing strong sulphuric acid, and wrapped with cotton wick soaked in a composition of chlorate of potash and flowers of sulphur, with pulverized white sugar and alcohol added to give consistency. This was capped with a leaden breaker, which projected beyond a paper case in which the tube and wrapper were enclosed, and the whole inserted within a fuse-case partially filled with hard driven mealed powder. This was ignited on firing, and soon burned away, leaving the glass tube unprotected, so that the weight of the breaker would cause it to be shattered on striking an object, setting fire to the wrapper, which in turn exploded the bursting charge.

Splingard's Belgian concussion fuse contained a conical tube of plaster of paris closed at top surrounded by ordinary fuse-composition, which in burning left the tube unsupported, allowing it to break when striking, so that the fire should communicate directly with the charge.

Fuses which explode by percussion or concussion present no difficulty when employed with elongated projectiles for rifled guns, which strike point foremost; and a variety of such, differing slightly in details of construction, have been successfully employed.

Bickford's fuse, English patent, 1831, was specially intended for miners' use.

It consists of a cylinder of gunpowder or other explosive matter covered by a double layer of cord and varnished. A similar fuse covered with a waterproof composition was designed for submarine blasting.

In electric fuses the heat necessary to fire the charge is imparted either by the passage of the current through a fine wire, usually platinum, or through a chemical mixture rendered conducting by containing a salt of copper. *f* illustrates one of the former, in which the gutta-percha covering is removed from the ends of the conducting wires, which are connected by a fine wire of platinum; these, with the charge of fine grained powder, are enclosed in a water-tight envelope of gutta-percha. *g* is one of the second class, known as Statham's. Its operation depends on the fact that a copper wire covered for some time with vulcanized rubber becomes coated with a layer of sulphide of copper, which is a moderately good electric conductor. This is utilized by twisting a piece of rubber-covered wire so as to form a loop, when part of the covering is removed as shown at *a*, and the wire severed. Consequently, when a spark is passed along the wire, on reaching this spot it must follow the film of sulphide adhering to the rubber; and the resistance which it has to overcome causes the sulphide to ignite.

i j k illustrate Shaffner's blasting fuses and cartridges. *i*, a hollow cartridge provided with central and diverging spaces occupied by a series of fuses and loose nitro-cotton, the whole covered with a water-proof casing into which the ends of the conducting wires pass.

j. The main wires which pass to the mine or cartridge are connected by smaller wires to the fuses, a number of which are placed in a single charge of explosive material.

k is provided with a wooden head enclosed in an indented cylinder closed by a cap; the head has a recess for the fuse composition, and another for the non-conducting cement which surrounds the wires where they enter the head.

h is the Abel fuse. This consists of a wooden head having a central longitudinal opening and two parallel transverse ones. Through the former two insulated conducting wires are passed, the ends *b* of each being cut off smooth at some distance from the head, and covered with a tin-foil cap containing priming. The gutta-percha is removed from the other ends of the wires, and they are inserted and secured in the two transverse holes before mentioned. When required for use, a case containing fine grained powder is fitted over the shoulder *c* and secured by twine.

Bishop's electric fuse *d e* comprises an inner and outer cylinder protected by a perforated cap through which the separately insulated conducting wires pass.

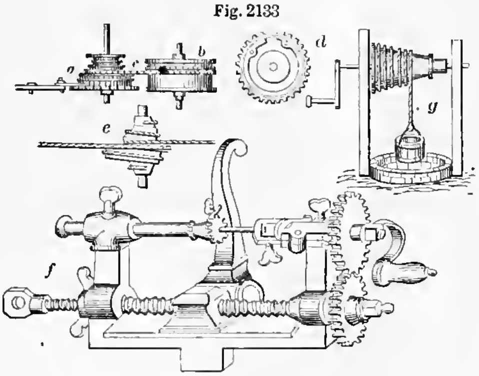
Fuse-cut'ter. An implement for gaging time-fuses to the desired seconds and fractions. The Bormann, or metal-fuse cutter, is merely a small gouge, about one tenth of an inch in width across the blade, and is used for cutting away the thin shell of metal which overlies the fuse-composition. The cutter for paper fuses for rifled guns, which necessarily are required to burn much longer, is more usually called a fuse-gage. It is a block of wood with a graduated brass gage let into one side, and having a hinged knife working on the same side, like a tobacco-knife, by which the fuse, which is marked on the side to seconds and fractions, is cut off so as to burn any required length of time.

Fu-see′. 1. A conical pulley *a* used in connection with a spring, and designed to equalize the power of the latter. The spring is coiled within the barrel *b*, and when fully wound up and at its greatest tension the chain *c* is wound upon the fusee and draws upon its smaller portion. As the fusee unwinds, by the motion of the train of gearing in the watch, the spring also uncoils and loses a part of its tension; as this proceeds, the chain draws upon a larger portion of the fusee, and attains an increased leverage on the latter to counterbalance the decreased power of the spring. The object is to obtain an equal power at all times, so that the watch may run regularly.

The *first* wheel of a watch is attached to the *fusee*.

The *going-fusee*, invented by Harrison to continue the motion of the watch while it is being wound up, has an auxiliary spring *d* through which the power of the mainspring is communicated to the wheels. While the watch is being wound, a ratchet and click prevent the reaction of the auxiliary spring, which

Fig. 2133



Fusee-Machine.

acts during the time of winding, although the power of the mainspring is removed. The chain connecting the *barrel* and *fusee* has hooks at each end; in winding, the chain is wound off the former on to the latter. The *fusee* cannot be introduced into very flat watches, and the first wheel, in that case, is attached to the *barrel*. The latter is then called a *going-barrel*, having teeth cut on its sides.

A double fusee (*e*) to communicate a variable reciprocating motion is used in Roberts's self-acting mule.

2. A cigar-lighter made of cardboard impregnated with niter and tipped with a composition which ignites by friction.

3. A *fuse*.

4. A light firelock or musket. The name is antiquated. A *fusil*.

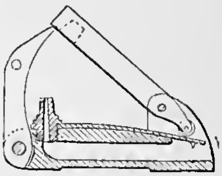
Fu-see′-ma-chine′. A machine (Fig. 2133) for cutting the snail-shaped or spirally grooved wheel on which the chains of certain descriptions of watches are wound. It was invented by the renowned Dr. Hooke about 1655. The machine (*f*) shown is the form that was used in 1741, and illustrates the idea thoroughly. It is also interesting as being the first machine in which *change-wheels* were used, and is the germ of the screw-cutting lathe. — THIRION, 4to, Paris, 1741.

Fu-see′-wind′lass. A pump-windlass with a conical barrel (*g*, Fig. 2133).

Fuse-ex-tract′or. This implement is designed for extracting wooden fuses from shells. It has jaws which grasp the fuse while the lower part of the extractor rests upon the shell. The jaws are attached to a screw, which works in a screw-socket in the body of the extractor, and has an iron lever passing through its head. The jaws being clasped around the projecting part of the fuse, it is drawn by turning the lever.

Fuse-lock. For miners. A spur on the spring attaches the lock to the fuse when the hammer is set. The dog is pulled by a long cord from a distant position of safety, releasing the hammer, which explodes the cap and lights the fuse.

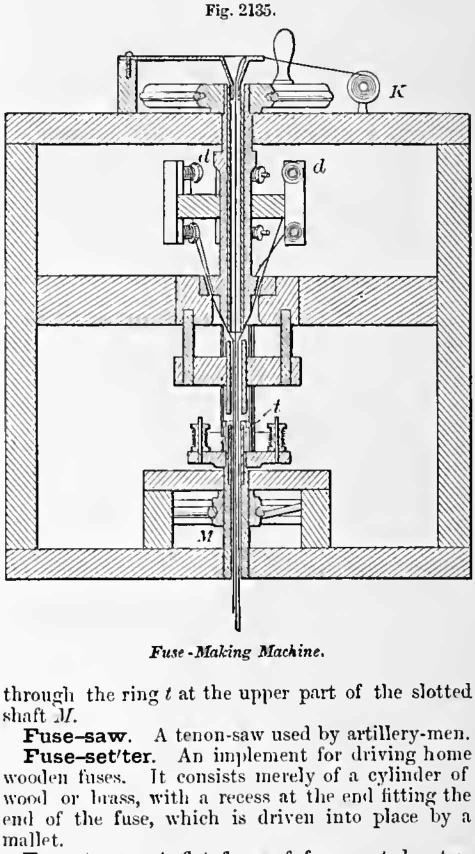
Fig. 2134.



Fuse-Lock.

Fuse-mak′ing. A machine having a vertical rotary shaft through which the powder descends around a central cord delivered from the spool *K*. Threads from the spools *d d*, etc., placed on a rotating frame, are wound about it as it descends, forming a twofold covering, which is compacted around the composition as the fuse passes

Fig. 2135.



Fuse-Making Machine.

through the ring *t* at the upper part of the slotted shaft *M*.

Fuse-saw. A tenon-saw used by artillery-men.

Fuse-set′ter. An implement for driving home wooden fuses. It consists merely of a cylinder of wood or brass, with a recess at the end fitting the end of the fuse, which is driven into place by a mallet.

Fuse-tape. A flat form of fuse, coated externally with pitch or tar, and *served* to prevent the coating from cracking, or covered with two warps and an interposed lap of cotton. Other forms might be noticed.

Fu′si-ble-al-loy′. An alloy, usually of lead, tin, and bismuth, compounded in such definite proportions as to melt at a given temperature.

Used as plugs in steam-boilers, so as to melt when a certain pressure and heat is attained and allow steam to escape. See ALLOY, p. 62.

Fu'si-ble-plug. One placed in the skin of a steam-boiler, so as to be melted and allow the discharge of the contents when a dangerous heat is reached. See "Le Dictionnaire de Industrie, Manufac., Commerc., et Agricole." Par A. Baudrimar. Blanque ainé et autres. Paris, 1833. Vol. 1. p. 326.

Fu'si-ble-por'ce-lain. A silicate of alumina and soda obtained from cryolite and sand, fused and worked as glass.

Cryolite is a mineral consisting of fluoride of aluminium and sodium. It is found in great abundance and purity in Greenland, and serves to make a fine milk-glass, which is called fusible porcelain. It is known in Bohemia and Silesia as milk-glass. One part of cryolite is mixed with two to four parts of quartz or pure sand, thus being a silicate of alumina and soda, containing some fluorine that has not been dissipated during the melting process. The material is easily wrought into any form, and may be readily ground and polished. It is stronger than common glass, and is said to withstand the fire better.

Fu'sil. A light fire-arm or musket of an antiquated pattern.

Fus'ing-points. (Some boiling-points and other data are added for the purpose of comparison.) By P. H. Van der Weyde, M. D.

	Fahr Degrees.
Platinum ; iridium ; osmium	3,992
Manganese	3,452
Cobalt	3,272
Melted tin boils	3,092
Pure bar-iron ; nickel	2,912
White heat of iron	2,372
Gold ; white cast-iron	2,282
Silver	1,832
Copper	1,742
Brass ; bronze	1,652
Aluminium	1,562
Full red-heat of iron	1,472
Magnesium	1,382
Cherry-red heat of iron	1,292
Iron, red-hot, visible in daylight	1,112
Iron, red-hot, visible in dark	932
Barium	887
Sulphur boils	842
Antimony melts ; cadmium volatilized	797
Tellurium	752
Zinc	707
Mercury and whale-oil boil	662
Lead ; cadmium	617
Amber melts ; linseed-oil and phosphorus boil	572
Watch-spring temper (deep blue)	554
Sword temper (blue)	536
Knife temper (pink)	518
Steam at 50 atmospheres	509
Bismuth melts ; steam at 45 atmospheres	500
Penknife temper (brown yellow)	482
Steam at 34 atmospheres	464
Chisel temper (yellow)	446
Tin melts ; steam at 24 atm.	428
Razor temper (straw) ; steam at 20 atm.	410
Pale yellow temper	382
Steam at 10 atmospheres	356
Camphor	347
Naphtha boils ; sulphur ignites	320
Turpentine boils	311
Low vulcanizing temperature	293
Steam at 3 atmospheres	275
Steam at 2 atmospheres	248
Sulphur	230
Water boils	212

	Fahr. Degrees.
Alcohol and benzine boil	176
Stearic acid ; white wax	158
Potassium ; spermaceti	131
Phosphorus	113
Blood heat	104
Lard	95
Ice melts	32
Mixture of salt and snow	0
Linseed-oil and brandy freeze	– 4
Mercury freezes	– 40
Liquid ammonia freezes	– 49
Carbonic acid freezes	– 112
Alcohol (thick as castor-oil) at	– 202

For fusing-points of alloys, see p. 62.

Fust. The shaft of a column from the astragal to the capital.

Fus'tian. (*Fabric.*) *a.* A heavy woolen cloth with a napped surface for men's wear.

b. A coarse, thick, twilled cotton stuff for men's wear, and generally of a dark color. The plain, common fustian is specifically known as *pillow*-fustian ; other varieties of fustian are known by the names of *corduroy, velverett, velveteen, thicksett, double-jean, velvet-tuft, moleskin* (cropped before dyeing), *beaverteen* (cropped after dyeing), *cantoon.*

These goods were first made in Norwich, England, in 1554, and were called "Norwich satins."

Fut'chel. (*Carriage.*) The jaws between which the hinder end of a tongue is inserted ; the similar parts in a wagon are called tongue-hounds.

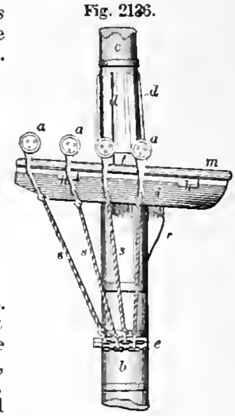
Fut'tock. (*Shipwrighting.*) One of the timbers in the compound rib of a vessel. A timber of the dimensions and form for the rib of a vessel cannot be procured in one piece ; the rib is built up of pieces scarfed together. The number is according to the length of the sections of the requisite hight. They are known as the *first, second,* and *third futtock,* terminated by the *top-timber.* See FRAME.

Fut'tock-hoop. (*Nautical.*) A hoop encircling the mast at a point below the head, and serving for the attachment of the shackles of the futtock-shrouds. See Fig. 2136.

Fut'tock-plank. (*Shipbuilding.*) The first plank of the *ceiling* next to the *keelson.* The *limber-strake.* The first plank of the *skin* next to the *keel* is the *garboard-strake.*

Fut'tock-plate. (*Nautical.*) An iron plate on the edge of the *top,* to which the *futtock-shrouds* and the *dead-eyes* of the topmast *shrouds* are secured.

Fig. 2136.



Futtock Plate and Shrouds.

s s, futtock-shrouds.
b, lower mast.
c, futtock-hoop.
a, dead-eyes.
c, topmast.
d, mast-battens.
h, cross-trees.
i, trestle-tree.
m, futtock-plate.
r, cheek or hound.
t, bolster.

Fut'tock-shrouds. (*Nautical.*) The short *shrouds* attached to the *chain-necklaces* on the mast, and to the sides of the top, by which ascent is had from the principal shrouds to the top. See Fig. 2136.

Fyke. A bag-net, open to allow fish to enter, but opposing their exit.

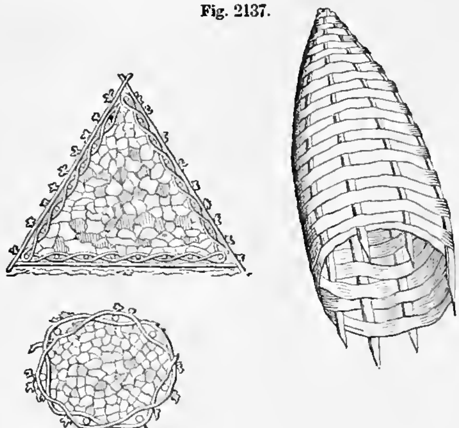
G.

Gab. The hook on an eccentric-rod which engages the wrist on the rock-shaft lever of a valve-motion. The word *gab* means *mouth* in several languages, and the term signifies that it is open to *bite* upon that placed within it. See Gab-lifter.

Gab′ar-age. (*Fabric.*) A coarse linen packing-cloth.

Ga′bi-on. A long basket of osiers or withes. When filled with earth, they are adapted to revet

Fig. 2137.



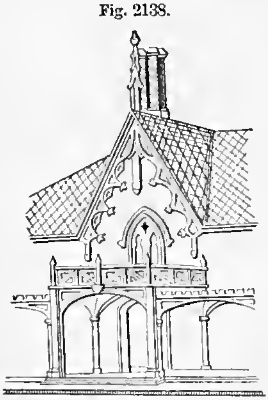
Gabions.

parapets and embrasures of fortifications. They are also used in other earthworks, such as batteries or rifle-pits.

Gabions filled with stones are used in civil engineering as defences for *starlings* of bridges; for making *dikes* or river-walls, where the shore is subject to washing; for making isolated islands, or chains of such, off shore, as a breakwater; also to arrest silt, sand, and mud, and gradually raise the bottom above the level of high-water, in the manner of *groins*.

Military engineers make their gabions about 20 feet long, and 3 feet in girth on the mean, with bands at distances of from 1 foot to 1 foot 6 inches; in Holland the gabions are made from 24 to 27 feet long, from 1 foot 4 inches to 1 foot 8 inches in girth, and with bands at every 6 inches apart; and upon the Upper Rhine the gabions are made from 2 feet 6 inches to 3 feet 4 inches in girth.

Fig. 2138.



Gable.

The gabions of the Greeks, used in forming foundations or making inclined planes for raising architraves of buildings, were baskets of sedge filled with chalk and called *herones*.

Ga′ble. The triangular portion of the end of a building, bounded by the sides of the roof and a line joining the eaves.

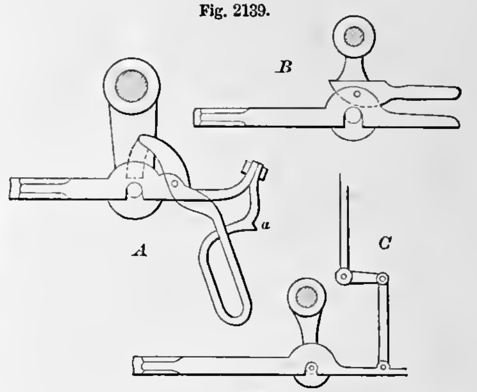
Gable-window; a window in the gable of a house.

Ga′blet. A small ornamental gable or canopy formed over a tabernacle or niche.

Gab-lift′er. A device for lifting the *gab-hook* from the wrist on the crank of the rock-shaft, in order to disconnect the eccentric from the valve-gear. In small engines, the eccentric-rod is simply lifted by means of the handle on the end.

In the apparatus *A*, by pulling up the spring han-

Fig. 2139.



Gab-Lifters.

dle below until it catches in the notch *a*, the pin is disengaged from the *gab* on the eccentric-rod.

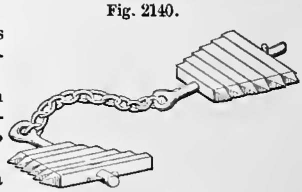
In *B*, the *gab* is lifted by the oscillation of an eccentric. When the handle of the latter is raised, the eccentric surface bears down on the pin and pries out the *gab-hook*.

In *C*, the operating rod proceeds from above and oscillates a rock-shaft, from which is suspended a link reaching to the eccentric-rod.

Gad. (*Mining.*) *a.* A steel wedge for opening crevices, natural or made by the pick.

The figure shows the mode of carrying them.

Fig. 2140.



Gads.

b. A small iron punch with a wooden handle, used to break up ores.

c. A *jumper*; a boring-bar.

Gaff. 1. (*Nautical.*) The spar which extends the upper edge of fore-and-aft sails, such as the *main*-sail of a cutter, smack, or other one-masted vessel; the *main* and *fore* sails of a schooner, the *spanker* of a ship, the *try*-sails or *spencer* of a brig or ship.

The lower end of the *gaff* has *jaws* which rest against and partially grip the mast. It is supported by the *throat-halyards* at the mast and the *peak-halyards* at the outer end.

The ropes which steady the *gaff* laterally are called *vangs*.

Gaff-sails are bent at the weather-leech to masts, or to *hoops* or *hanks* which run on the mast as the sail is raised or lowered.

2. The metallic spur fastened to the leg of a fighting-cock.

Cock-fighting was a common amusement in England in the twelfth century, and Fitz-Stephen says that it was customary for the schoolmaster to superintend the pit on the usual holiday cock-fighting on Shrove-Tuesday. The English, like the ancient Greeks, armed the heels with spurs. So, after all, our St. Domingo period was not so very long ago.

3. A fish-spear.

Gaff-hook. A heavy, barbed hook with a line, used in landing large fish.

Gaff-top'sail. A sail spread by a gaff above the main-sail of a cutter, or other fore-and-aft rigged vessel.

Gage. 1. An instrument for determining distances, sizes, proportions, as the carpenters' gages of various kinds; sheet-metal and wire gages, which are standards of measurement of thickness; test-gages or templets, by which work in detail is made to an exact set of standards, so that the pieces may be assembled; as the Springfield and other rifles, the Singer and other sewing-machines. There are about seventy-eight gages used for determining and verifying dimensions of the parts in the rifle musket, pattern of 1855; its lock, stock, barrel, ramrod, leaf-sight, bayonet, and mountings.

Whitworth's contrivance for testing the truth of a solid measure representing an English inch is a remarkable specimen of mechanical skill and accuracy. The block representing the inch is a rectangular prism of polished steel, originally cubical, but having its angles so truncated for convenience of manipulation that the terminal surfaces are one quarter inch square. At one of its extremities it abuts against a fixed stop, the other is opposed to the extremity of a screw of twenty threads to the inch, placed directly in the line of the axis. A single revolution of the screw advances the extremity, therefore, one twentieth of an inch. But the head of the screw is ten inches in circumference, and is divided into 200 parts. In turning this wheel, every division accordingly advances the screw one four-thousandth part of an inch. The divisions, however, are not traces, but teeth; and the screw-head is a gear-wheel, which is driven by a tangent screw lying horizontally in its plane and across its summit. And this tangent screw has also a head of 12½ inches in circumference, which is divided into 250 parts, each part being the twentieth of an inch. An entire revolution of the tangent screw advances the gear-wheel only one tooth, which, as we have seen, moves forward the end of the measuring screw one four-thousandth of an inch. A single division of the limb of the tangent screw-head will therefore produce a movement in the direction of measurement of only one two-hundred-and-fiftieth of one four-thousandth of an inch; that is to say, of one one-millionth part of an inch. Between the plane face of the standard inch and the extremity of the measuring screw opposed to it is a little steel plate with parallel and perfectly true surfaces. As the screw advances towards the plate a point is reached where the latter appears to be in contact, but when lifted it will be found to be free, as it will fall freely back, not being held by friction. If now the tangent screw be turned, a single division at a time lifting the plate after each movement, a point will be reached at which a single additional movement of advance will fasten the plate completely, so that the friction will prevent its fall.

Between these points the screw is advanced $\frac{1}{1000000}$ of an inch, and a retraction of the screw to this extent will free the plate so that it will fall; care being taken that disturbance of the equilibrium of temperature shall not change the conditions.

Whitworth's cylinder gages at the Paris Exposition were perforated steel plates, the perforations being highly polished within, and differing from each other in diameter by $\frac{1}{10000}$ of an inch. Corresponding to them were polished steel cylinders, one exactly fitted to each. As these cylinders lie side by side, it would be difficult for the eye to distinguish a difference of diameter between several of them; but when they are tried by the gages, each will pass freely through the aperture corresponding to its own number, but no one can be forced without an effort into one of a higher order. See MEASURING-MACHINE.

2. (*Physics.*) An instrument for determining the condition of a fluctuating object; as a tide, steam, rain, water, wind, current gage, etc. See METER.

3. *a.* The quantity of plaster of paris added to plastering mortar to facilitate setting.

b. Fine mortar with an addition of plaster of paris for a finishing coat.

4. The width of a railway track. See RAILWAY-GAGE.

5. The length of a shingle, slate, or tile which is exposed to the weather. Also called the *margin.* The hidden portion is called the *cover.*

a. Shingles are 18 inches long and expose 6 inches. That is the *gage.* There are thus three thicknesses on a roof.

b. Plain-tiles are 10½ inches long and have a gage of 6½ inches.

c. Pan-tiles are 14½ inches long; gage, 10 inches.

d. Slates vary in length and size. The gage is usually nearly half the length, so that the slates have a little over two thicknesses on the roof.

6. (*Printing.*) A strip of reglet with a notch in it to indicate the length of a page.

7. The depth of immersion of a vessel.

See under the following heads: —

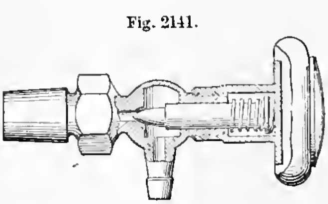
Angle-gage.
Auger-gage.
Axle-gage.
Ball-caliber.
Barometer-gage.
Barrel-gage.
Barrel-filling gage.
Bilge-water gage.
Biseeting-gage.
Boarding-gage.
Boring-gage.
Broad-gage.
Bur-gage.
Caliper-gage.
Carpenter's gage.
Center-gage.
Chamber-gage.
Clapboard-gage.
Coffin-gage.
Condenser-gage.
Counter-gage.
Croze.
Current-gage.
Cutting-gage.
Depth-gage.
Diamond-gage.
Drill-gage.
Electric steam-gage.
Evaporation-gage.
Gage and caliper.
Gage-box for shingles.
Gage-cock.
Gage-concussion.
Gage-dial.
Gaged brick.
Gage-glass.
Gage-ladder.
Gage-lathe.
Gage paper-cutter.
Gage-pile.
Gage-rod.
Gage-saw.
Gage-wheel.
Gaging caliper.
Gaging-rod.
Gas-fitters' gage.
Gas-gage.
Grain-gage.
Gun-barrel gage.
Hydraulic indicator.
Index-gage.
Joiners' gage.
Knitting-gage.
Liquor-gage.
Marking-gage.
Measuring-apparatus.
Meter (varieties, see METER).
Meter-gage.
Mortise-gage.
Narrow-gage.
Nipper-gage.
Page-gage.
Pear-gage.
Plasterers' gage.
Pressure-gage.

Printers' gage.
Railway-gage.
Rain-gage.
Recording-gage.
Ring-gage.
Rounding-gage.
Router-gage.
Salt-gage.
Saw-gage.
Sawing-machine gage.
Screw-cutting gage.
Screw-thread gage.
Scribing-gage.
Sea-gage.
Setting-gage.
Sewing-machine gage.
Sheet-metal gage.
Shell-gage.
Shingling-gage.
Shingles. Gage-box for
Shot-gage.
Sliding-gage.
Slitting-gage.
Spectacle-gage.
Speed-gage.
Spoke-gage.
Standard-gage.
Star-gage.
Steam-gage.
Stepped-gage.
Surface-gage.
Templet.
Testing-gage.
Thermometric steam-gage.
Tide-gage.
Tool-gage.
Tucking-gage.
Turning-gage.
Vacuum-gage.
Water-gage.
Weather-boarding gage.
Wind-gage.
Wire-gage.

Gage-box for Shin'gles. A box of a certain size in which shingles are laid to form bunches of a certain number. A shingle is about 18 inches long, and every 4 inches of the edge counts as one shingle, so that if it were 12 × 18 inches it would count as 3. The box being 2 feet square, and the tails of the shingles lapping 6 inches, the butts of the layers are presented in alternate directions, each layer counting as six shingles. The box facilitates the counting and bunching.

Gage-cock. (*Steam-engine.*) One of two or more stop-cocks which are screwed into the boiler, one above the level at which water ought to stand in the boiler and the other below it. The ejection of steam and water respectively from the cocks indicates the water-level in the boiler to be between the two gage-cocks. Steam from both shows the water to be too low. Water from both shows the water to be too high.

Fig. 2141.



Gage-Cock.

In the gage-cock shown, the valve is operated in one direction by the tubular cap, and in the other by the steam pressure and a spring.

The *water-gage* is an exterior, vertical tube in connection with the boiler, and in which the water rises to an equal hight.

Gage-con-cus'sion. The rocking laterally of a railway carriage bringing the flanges of the wheels in contact with the edges of the rails.

Gaged-brick. Bricks for arch-building, molded or rubbed to a wedge shape to suit the radius of the soffit.

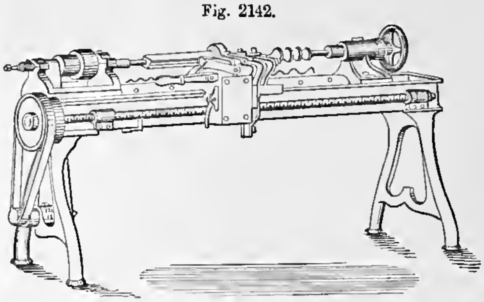
Gage-glass. (*Steam-engine.*) A strong, vertical, glass tube, connected at its ends by two cocks to the boiler, and forming an indicator of the depth of water in the boiler. It is illuminated at night by the *gage-lamp.*

Gage-lad'der. A square timber frame for raising the ends of wheeling planks in excavating. A *horsing-block.*

Gage-lamp. (*Railroad-engine.*) A lantern to throw light on the water-gage of a steam-boiler.

Gage-lathe. One designed to turn out chair-rounds, banister-columns, and all similar objects in which the cylindrical form is modified by contraction or enlargement of diameter, the formation of beads, etc., so as to present curves or broken lines in its contour.

Fig. 2142.



Gage-Lathe.

The wood is placed between the centers, and is first brought to the form of a regular cylinder by means of a fixed chisel in a slide-rest. The slide-rest has two chisels, one of which reduces the wood to the form of a uniform cylinder, while the other cuts away the portions of the cylinder which must be removed in order to produce the varied outline which the design requires. This latter chisel is in a hinged holder, and a foot firmly connected with it rests on an iron rail or gage, which is cut to the contour which the wood is to have. As the slide-rest advances, this foot rises on the swells and sinks into the depressions of the gage; and the tool-holder, with its tool, rises and sinks with it, and thus transfers to the wood the precise contour of the gage. See NURLED WORK.

Gage Pa'per-cut'ter. A machine having a guillotine-knife descending with a draw-cut upon a pile of paper on a table. An adjustable fence regulates the *gage*, or size. See PAPER-CUTTING MACHINE.

Gage-pile. (*Pile-driving.*) A preliminary pile to mark the desired course.

Gage-rod. A graduated rod, used in measuring the capacity of barrels and casks.

Gage-saw. A saw having an adjustable frame or clamp, which determines the depth of kerf. Used by comb-makers and others.

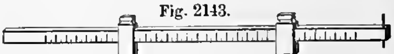
Gage-stuff. A stiff and compact plaster used in making cornices, moldings, etc. It consists of two thirds fine mortar, one third plaster of paris, with a little water.

Gage-wheel. One attached to the forward end of a plow-beam, to gage the depth of furrow.

Gag'ger. (*Founding.*) A T-headed piece of iron with a shank gradually enlarging towards the end, and placed in a mold so as to lock the sand together.

Gag'ing-cal'i-per. A tool in which are combined dividers, inside and outside calipers, and a graduated double scratch-gage. It is graduated to 16ths, 32ds, and 64ths of an inch.

Fig. 2143.



Gage-Caliper.

Gag'ing-rod. An exciseman's or inspector's measuring-staff, for determining the interior dimensions of casks and other vessels holding liquids.

Gag-rein. (*Saddlery.*) A rein which passes over *runners* attached to the throat-latch, so as to draw the bit up into the corners of the horse's mouth when pulled upon.

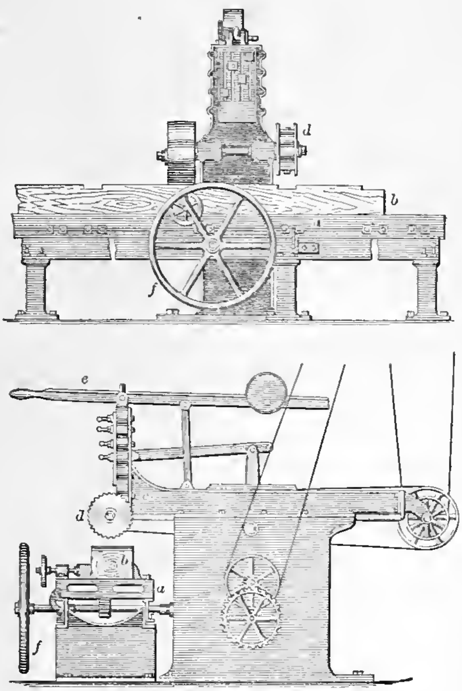
Gag-run'ner. (*Harness.*) A loop depending from the throat-latch ; through it the gag-rein passes to the bit.

Gain. A mortise.

A beveled shoulder of a binding joist to strengthen the tenon.

Gain'ing-ma-chine'. A machine for cutting grooves across the face of a beam, usually to receive the shoulder of the tenon, so that the stud joist or post framed into the beam may have a strength to resist lateral strain greater than that due merely to the tenon which rests in the mortise proper. The machine is also adapted for rabbeting and transverse cutting generally. Two circular saws are placed at a distance apart equal to the width of the desired gain. A routing cutter may clear out the chip between the kerfs. The beam *b* is dogged on the bench *a*, and the saw-carriage *c* reciprocates above it, the

Fig. 2144.



Reciprocating Cross-Gaining Machine.

saws *d* being brought down to the work by the counterbalanced lever *c*. *f* is the wheel whereby the beam is moved longitudinally the distance between gains.

Gain'ing-twist. (*Rifling.*) A rifle-groove whose angle of twist becomes greater towards the muzzle. This allows the ball to be more easily started, gaining a greater velocity as it proceeds towards the muzzle. *Increase twist.*

Gai'ter. A covering for the ankle, fitting down upon the shoe. It is usually buttoned or buckled upon the outer side, and has a strap beneath the shank of the shoe.

It is sometimes called a gaiterette, as the term *gaiter* has been colloquially applied to the half-boot with a cloth top, and more recently to all bootees which closely embrace the ankle and the small of the leg immediately above it.

Ga'la. (*Fabric.*) A Scotch cotton fabric.

Gal'a-o-tom'e-ter. An instrument for ascertaining the quality of milk by its specific gravity. A *lactometer*. The former term is founded upon the Greek, and the latter partially from the Latin.

It consists of a stem and bulb, the latter charged with shot serving as ballast, so that it floats upright in the milk, the relative specific gravity being indicated by the centessimally graduated stem.

Gal'e-as. A low-built French galley worked with sails and oars. *Galeasse*, a Venetian galley. *Galiot*, a Dutch galley.

Ga-le'na. Native sulphuret of lead ; from *galeo*, to shine.

Gal'ets. The splinters of stone broken off by the stroke of the mason's chisel. Also called *spalls*.

Gal-i-le'an-tel'e-scope. The original form of reflecting telescope used by Galileo. It has a convex, converging object-glass, and a concave, diverging eye-glass. See TELESCOPE.

Gal'i-ot ; Gal'li-ott. (*Nautical.*) Formerly, a galley propelled by sails and oars, having one mast and 16 to 20 seats for rowers ; used by most of the maritime nations of continental Europe, and called by substantially the same name in the Latinic languages. Now a strong and cumbrous, bluff-bowed, two-masted vessel, used in the Dutch merchant service.

Gal'le-on. A large Spanish vessel with three decks, formerly used.

Gal'ler-y. 1. (*Fortification.*) A covered passage in a work, either for defence or communication. As one beneath the counterscarp and loopholed, or communicating between the enceinte and an outwork.

A gallery in a *scarp* having *embrasures* becomes a *casemate*.

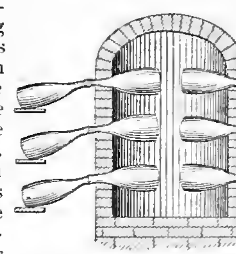
2. (*Nautical.*) A balcony projecting from the after part of a ship, as the *quarter-gallery*, *stern-gallery*.

3. A corridor ; a partial story in a room for auditors or musicians.

4. (*Mining.*) An adit or drift in a mine, either as a means of working, of drainage, or of ventilation. The great drainage-gallery of the mines of Clausthal, in the Hartz, is 11,377 yards, equal to 6½ miles long, and passes 300 yards below the church of Clausthal. Its excavation occupied from 1777 to 1800, and cost about $330,000. See ADIT.

Gal'ler-y-fur'nace. A furnace used in the distillation of green vitriol, consisting of a long gallery containing two or three tiers of retorts, 100 in each row. The gallery is a flue traversed by the flame of a fire. The neck of each retort projects through the walls of the gallery and enters an exterior receiver.

Fig. 2145



Gallery-Furnace.

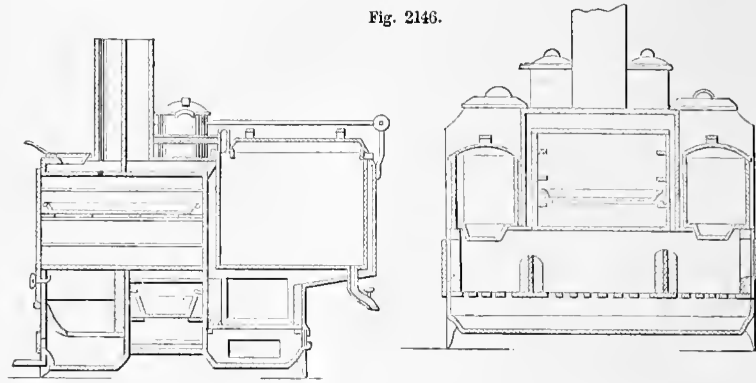
Gal'ley. 1. (*Nautical.*) *a*. A low, flat-built vessel with one or more rows (*banks*) (see BANK, 5, *a*) of oars, said to have been invented by the Corinthians 700 B. C. The *biremes*, *triremes*, *quinqueremes*, etc., were galleys having so many banks of oars, — two, three, five, etc. The *pentecontori* had fifty oars in a single tier. The *galeasses* of the Venetians had 130 feet keel, 30 feet beam, three masts, thirty banks (see BANK, 5, *b*) of two oars each, each oar manned by six chained slaves. They were introduced into France in the reign of Charles VI., and manned by criminals. He kept forty in his service. They were abolished by Louis XV. in 1748.

b. A clinker-built boat for ship's use, from 28 to 36 feet long, and with a beam equal to .2 of its length. It is a light, sharp boat, carrying from ten to twelve oars, and is used for speedy rowing on expeditions. It usually has six alternate oars rowed by a picked crew.

c. The cook-house on board ship which is on deck, or in a forward part of the vessel.

In the example, the caboose has three grates in front so arranged that one or all may be used at a time, and a rear grate, over which are three large boilers. Over a central front grate is a large oven, and between the front and rear fires is another; the products of combustion from the front fires circulate up around and over the front oven, on top of which are apertures for cooking-vessels; boilers may be placed over the side fires; and, on the top of the stove, boilers or cooking-vessels may be used. Pipes from the top of the large boilers convey the steam arising in cooking to the smoke-flue. Convenient arrangements are provided for the draft and for removal of ashes. The smoke-flue is so divided by a central partition as to give separate passages from the front and rear fires.

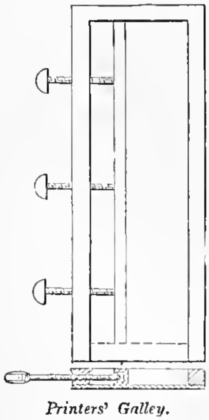
Fig. 2146.



Ship's Galley.

2. (*Printing.*) An oblong tray which receives matter from the composing-stick, and on which it is arranged in a column or page. The galley has a ledge on both sides and at top, half an inch in hight. From this it is taken to the imposing-stone and arranged in a chase. The galley sometimes has a groove to admit a false bottom, called a *galley-slice.*

Fig. 2147.



Printers' Galley.

In that illustrated the space for the matter is adjustable in width by a straight *side-stick* and thumb-screws, so as to *lock up* the *matter.*

Gal'ley-roll'er. (*Printing.*) A short inking-roller for taking *slip* proofs of matter in galley.

Gal'ley-slice. (*Printing.*) A sliding false bottom of a galley. See GALLEY.

Gal'ley-stick. (*Printing.*) A long tapering stick less than type high, which is placed beside a column of type in a galley, and the whole *locked up* or wedged in place by *quoins.*

Gal'li-vat. A large East Indian rowing-boat.

Gall of Glass. Scum of melted glass. *Sandiver.*

Gal-loon'. (*Fabric.*) A narrow cotton fabric used for binding shoes, etc.

A narrow binding stuff with threads of gold and silver. A silk, woolen, or mixed tape for edging, binding, or shoe-strings.

Gal'lows. 1. (*Husbandry.*) The central core of four corn-stalks interlaced diagonally, and bound at the intersection, forming a *stool* or support for cut corn, which is bound around it to form a *shock.*

2. (*Printing.*) The rest for the tympan when open.

3. The frame supporting the beam of a steam-engine.

4. A frame on which criminals are hanged.

Gal'lows-bitts. (*Nautical.*) A strong frame erected amidships on the deck to hold spare spars.

Ga-loche'. 1. A clog or sabot.

2. An overshoe.

3. A legging.

Gal-van'ic Ap'pa-ra'tus. (*Medical.*) Contrivances of various character and application, but agreeing in this, that they keep up a certain amount of galvanic action, which is intended to exert a remedial effect upon the parts of the body to which they are applied. While one cannot speak with confidence as to the actual value of such, we cannot condemn them, for we have but a very imperfect understanding of principles, and for the larger proportion of the curatives we possess we are indebted to empirics. This term ought not to be considered as one of reproach, for experiment has given us about all we have; rather look for the charlatans among those who pretend to have penetrated the arcana. Among the galvanic appliances may be cited bands, belts, chains, combs, rings, soles, spectacles, etc.

Gal-van'ic Bat'ter-y. Galvani, of Bologna, first observed the motion of the muscles of a frog under dissection, when the latter, lying upon a copper plate, were touched by a steel scalpel, exciting an electric current. He pursued the subject by specific experiments. Volta, of Como, repeated them, and originated the voltaic pile in 1800; also demonstrating that the influence was incident to the action of the metals, and did not abide in nerves; in fact that it was a current of electricity passing along the nerves and muscles. Duvernay in 1702 had observed and treated of the peculiar action of electricity, now known as galvanism.

Electricity, as developed by the galvanic pile, is great in quantity and weak in intensity. In this respect it is the inverse of the frictional electricity as excited by the electrical machine.

Galvanic electricity is also a steady current, while that of the electrical machine — as taken from the prime conductor — is intermittent and explosive.

From the proceedings of the National Institute of France, July 4, 1798: —

"Many of the members have been principally occupied with the care of ascertaining by a multiplicity of experiments the phenomena of galvanism. This name is given to a discovery which Dr. Galvani, a member of the Institute of Bologna, made many years ago, and from which it results that when a contiguous series of metals, commonly different from one another, are put into contact on the one side of a nerve, and on the other with a muscle, or even with different and distinct parts of the same nerve, at the instant of the double contact a rapid and convulsive motion takes place in the muscle into which the nerve is distributed. This phenomena seems to present to the mind the idea of a circle, a portion of which is formed by the excitatory metals, and the other by the nervous and muscular organs. The rapidity of the effect, and the promptness of the communication, the nature and the participation of the exciting and interrupting substances, present very sensible analogies between the phenomena of galvanism and those of electricity. Some essential differences, however, appear to militate against this analogy, and will not suffer us to admit, at least for the present, the identity of a common principle."

A simple galvanic battery *a* consists of two bodies relatively electro positive and negative, immersed (or partially so) in a fluid which tends to act chemically upon one or both; the metals touching each other or having a conducting circuit connection.

Or: A current may be obtained from two liquids and one metal (or other substances); the respective sides of the metal being exposed to liquids of varying chemical energy upon the metal so presented.

Chemical action in all batteries develops electric energy or electro-motive force. This power is derived from the expenditure of metal, etc., and the actual value of the materials used is the principal item in determining the economic value of the process as a means of developing power. Its usual application as a motor has been in the form of the electro-magnetic engine, with coils and armatures. See Electro-magnetic Engine.

Two substances, which are conductors of electricity, being placed in contact and subject to chemical action by the presence of a fluid, will develop electric action; negative electricity passing from the body which is acted upon most powerfully, — the more easily oxidizable metal, — and positive electricity from the other substance. This is not stated as a principle, but a fact.

The metals, etc., are arranged in a series, each one of which is positive to all below it in the scale. The order is as follows: —

Zinc.	Iron.	Gold.
Lead.	Brass.	Platinum.
Tin.	Copper.	Graphite.
Antimony.	Silver.	Charcoal.

The more remote they stand from each other in the series, the more energetic will be the electric action developed by their contact under circumstances to excite chemical action.

In the formation of a simple galvanic circuit, the chemical action which excites electricity takes place through a decomposition of the liquid.

For instance, when a plate of zinc and one of copper are plunged in a weak solution of sulphuric acid, oxygen, and hydrogen, the elements of the water are separated from each other: the oxygen unites with the electro-positive zinc, forming sulphate of zinc, and develops negative electricity therein; while electro-negative copper is contrarily excited, and positive electricity is said to flow therefrom.

Some misconception may arise in the mind when it is said so frequently in a description that electric currents *flow;* but this mode of expression is perhaps as good as has been devised, and is certainly quite common. This curious agent or excitement is so imperfectly understood, that Professor Faraday remarked: "There was a time when I thought that I knew something about this matter; but the longer I live and the more carefully I study the subject, the more convinced I am of my total ignorance of electricity." The terms *flow, current,* etc., must, therefore, be considered merely as convenient conventional expressions.

This much seems to be admitted, that the positive and negative currents are coïncident, and pass in opposite directions to restore equilibrium. In doing this they possess a certain energy which some ingenious men have made available as a positive force. In other cases the converse of the proposition is elucidated; as in electro-plating, where the energy derived from chemical action is made to excite electrical action; this again being transferred to a bath, where chemical decomposition is again effected and the equilibrium restored.

Volta discovered that by a repetition of the simple combinations, or, in other words, by a multiplication of the pairs of excited plates, the effect might be increased. His pile of plates arranged in pairs is but a multiplication of the single pair of plates, iron and copper, which caused the muscular action in the moist anatomical preparation of a frog with which they were casually brought in contact.

The cumulative effect of a number of simple batteries *b* (Fig. 2148) may be obtained by bringing them all into one circuit. Each copper plate is connected by a copper wire to the zinc of the next glass, and each transmits the electric current derived from the chemical action in its own glass, in addition to that derived from the action in the preceding glasses.

The trough-battery *c c'* was used by Sir Humphry Davy in his series of magnificent discoveries, 1806–8, when he isolated the metallic bases, calcium, sodium, potassium, etc. His trough had 2,000 double plates of copper and zinc, each having a surface of 32 square inches.

It is like the compound battery just cited, except that instead of separate glasses, a row of water-tight cells are made in a single trough *c'*, and the plates are united to a bar of wood *c* and connected by wires, the copper of each to the zinc of the next pair, and so on all through. This arrangement of the plates enables them to be withdrawn in a body from the dilute acid when desired.

The elements of the first galvanic batteries, copper and zinc plates immersed in a trough containing dilute acid, soon became sluggish and inert, and were capable of exerting their power for but a limited time without cleansing or renewal.

In 1836, Daniell's, the first permanent battery, was invented. This consists of a zinc and a copper element, each immersed in a separate saline solution, and separated by a diaphragm, originally of leather or animal membrane, but afterwards of porous earthenware. Smee subsequently substituted, for copper, silver upon which a coating of platinum was electrically deposited. Silver coated with platinum being cheaper and affording equally good results has been very generally employed, and latterly iron similarly coated has been used.

In the Austrian section of the Paris Exposition of 1867 there was exhibited a battery on the Smee principle, in which the positive element was fragments of amalgamated zinc, and the negative lead coated with platinum. This is said to be used in the Austrian telegraph-offices. Weak sulphuric acid is used as the bath in this battery.

A very permanent battery of low intensity has been devised by M. G. Farmer of Boston. It consists of an oval copper vessel forming the negative element, and which is nearly filled with a saturated solution of sulphate.

At one end is a porous cup within which is placed a smaller porous cup, which receives a cylinder of amalgamated zinc. The interior porous cup contains pure water, and the exterior cup a weak solution of sulphate of copper. The saturation of the liquid in the outer copper vessel is maintained by placing at the opposite end a third porous cup containing crystals of sulphate of copper, which are replenished as they are dissolved. If care be taken not to allow the water to fall too low, this battery will maintain its energy for many months.

Analogous to this is the battery of Fr. Secchi of Rome, which consists of a hollow cylinder of copper, having notches below to allow the liquid within and without to communicate freely, placed in the middle of a glass or earthenware cup, the bottom of which is covered with crystals of sulphate of copper. Over this is placed bibulous paper, fitting the annular space, over which is a stratum of sand on which rests a hollow cylinder of zinc surrounding the copper cylinder. This is filled with pulverized sulphate of copper. The space around the zinc is filled with sand. The whole is then moistened with water. According to the inventor, this battery acts for an entire year, water and sulphate of copper being added occasionally.

The gravity battery of M. Callaud of Nantes has a single cell, the separation of the liquids being effected by the difference in their specific gravities. The copper element is in the bottom, in the solution of sulphate of copper; and the zinc element is suspended in an upper part of the cell, in its own supernatant liquid. See CALLAUD BATTERY; GRAVITY BATTERY.

M. Leclanche employs in a carbon battery peroxide of manganese; subsequently he added carbon to the peroxide, the whole being ground into a paste.

Professor Bunsen, a few years since, introduced bichromate of potash instead of nitric acid in the battery bearing his name. This performs well for a time, but in consequence of the precipitation of sesquioxide of chromium upon the zinc it gradually loses power. Another modification dispenses with the porous cup, using the two liquids in mixture. The same objection attaches to this as to the former.

In the battery of Professor Thomsen of Copenhagen, a number of plates of platinum are immersed in dilute sulphuric acid, and are, by means of an electro-magnetic motor, successively brought into contact with the poles of a single cell of Daniell. The plates become covered by the decomposition of water with oxygen on one side and hydrogen on the other, giving rise to a powerful current in the platinum combination, which is maintained nearly constant when the contacts succeed one another rapidly and regularly.

To describe them more in detail: —

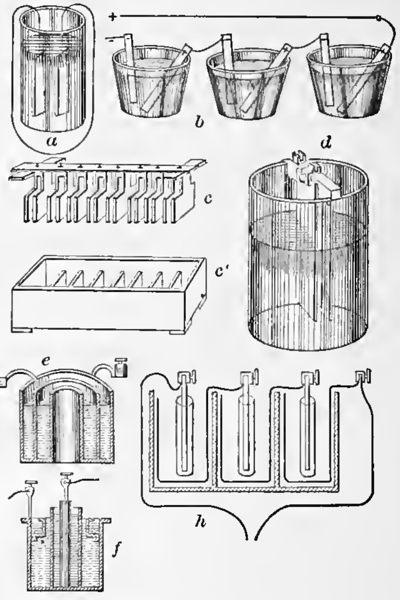
Smee's battery (*d*) has a plate of silver coated with platinum suspended between two plates of zinc, the surfaces of which have been amalgamated; that is, coated with mercury. The three plates are supported by a wooden bar, and depend within a jar partially filled with the usual acidulated solution, — dilute sulphuric acid. The wires and poles are connected with the zinc and platinum plates by small screw caps. The amalgamation of the zinc preserves the latter metal from active corrosion by the acid when the battery is not in use.

The sulphate-of-copper battery (*e*) has two concentric cylinders of copper joined to a bottom of the same metal. The middle cylinder is of zinc, and sets within the annular trough, which has a solution of sulphate of copper as an exciting liquid.

The screw caps are for attachment of the wires to the respective metals. A partition in the bath may be introduced, to allow the solution to pass, but restrain the passage of the solid products of the chemical decomposition. This would keep the metals free from a deposition which soon renders them inactive. The partition may be bladder or biscuit-porcelain.

Daniell's constant battery (*f*) is of the class of the sulphate-of-copper batteries. It differs from the preceding in having the sulphate of copper acidulated with one eighth of its bulk of sulphuric acid; in having a porous porcelain cylinder containing a solution of acid, 1 part; water, 7 parts; and in having a reserve of crystals of sulphate of copper on an

Fig. 2148.



Galvanic Batteries.

annular shelf in the bath. The reserve of acid and the salt of copper gives the battery a longer vitality and accounts for the name *constant*; and its continued effectiveness and evenness of action is due to the preservation of a clear metallic surface to the copper. The action is similar to the ordinary battery; the oxide of zinc formed is dissolved by the acid set free, but the hydrogen, instead of being set free at the copper plate, combines with the oxygen of the sulphate of copper, and the copper, thus set free from the acid, combines with the copper plate of the battery, and keeps a clear metallic surface thereon.

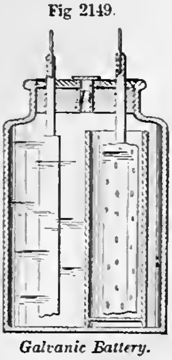
Grove's battery (*h*) is used for telegraphing and otherwhere when a powerful action is required. The glass jar has a cylinder of amalgamated zinc with an opening through one side to permit free circulation of the dilute sulphuric acid. Within this cylinder is a porous cup of biscuit-porcelain, containing strong nitric acid, in which is suspended a strip of platinum fastened to the end of a zinc arm projecting from the adjoining zinc cylinder.

An objection to this battery consists in its emission of corrosive nitrous-acid fumes.

In Bunsen's battery, the platinum of Grove's battery is replaced by carbon. The Bunsen cell, properly so called, has a cylinder of carbon immersed in nitric acid, and the porous cell, containing zinc and sulphuric acid, is placed within it. In another form, introduced by Archerau, the zinc and sulphuric acid surround the carbon cylinder and nitric acid, which are contained in an interior porous cell; in consequence of the greater proportion of positive surface, this latter form evolves a greater amount of electricity than the former. Bunsen's battery is more powerful, though less compact, than Grove's.

In the Leclanche battery, the porous vase has a graphite plate to form the positive pole, and is filled up with a mixture of powdered graphite and peroxide of manganese. The inclosing jar has a plate of zinc and is filled with sand or sawdust moistened with a concentrated solution of sal-ammoniac. The cork has a central glass tube, and over this is a disk of rubber, whose edges are secured to the wax, its middle slit forming a gas-escape valve.

Fig 2149.



Galvanic Battery.

A newspaper item gives an account of the "smallest battery," as follows: "Mr. Collett writes from Heart's Content, 'I have just sent my compliments to Dr. Gould of Cambridge, who is in Valentia, with a battery composed of a gun-cap, with a strip of zinc, excited by a drop of water, the simple bulk of a tear.'" A telegraph that will do that must be nearly perfect.

The principal galvanic batteries are known as, —

Bunsen battery.	Gravity battery.
Calland battery.	Grove battery.
Carbon battery.	Leclanche battery.
Daniell battery.	Single-fluid battery.
Double-fluid battery.	Smee battery.
Electropoion battery.	Thermo-electric battery.

See Deschanel's "Natural Philosophy," Part III. Appleton & Co.

Gal-van'ic Mox'a. A term applied by Fabré Palaprat to the application of platinum rendered incandescent by a galvanic current, as a cauterizing agent of the nature of a moxa.

Gal-van'ic Pile. A column of alternate plates, such as zinc and copper. See VOLTAIC PILE.

Gal'van-ized I'ron. The iron is cleaned by dilute acid and friction, is heated and plunged into a bath of melted zinc covered with sal-ammoniac, and is stirred about until the surface becomes alloyed with zinc. Small articles are treated in the same way, and, as they are found to be soldered together by the metal when dipped therefrom by the skimmer, they are placed in a crucible with charcoal powder, heated and shaken. Chains taken out of the zinc are shaken to separate the links. Wire is reeled through the zinc. Mallett recommends an amalgam of zinc, 2,292; mercury, 202; and about 1 of sodium or potassium; this melts at 680° F. The cleansed iron is dipped in this, and removed as soon as it reaches the temperature of the alloy.

Morewood and Rogers's method. The plates are tinned by placing them in a solution of muriate of tin in a bath, the plates alternating with granulated zinc, and thus forming a weak battery by which tin is deposited on the iron. The plates are then passed through a bath of melted zinc.

Gal-van'o-graph. (*Engraving.*) An Austrian process. A plate of silvered copper is covered by an artist with different coats of a somewhat transparent pigment, so that on the dark portions the paint is thick and raised, and the surface is relatively depressed in the light tints. A copy of this is made by the electrotype process, the darker being now the deeper portions, the whole forming an intaglio, like a copperplate, and is printed from by the copperplate-printing process.

Gal-van'o-glyph. A form of engraving. A ground is spread on a clean zinc plate and etched. Succeeding coats of varnish are spread by a roller on the ground, avoiding the obliteration of the lines, which become deeper with each coat. The finished plate becomes a matrix for a reverse impression obtained in the electro-bath, and this reverse is used to print from in the ordinary manner.

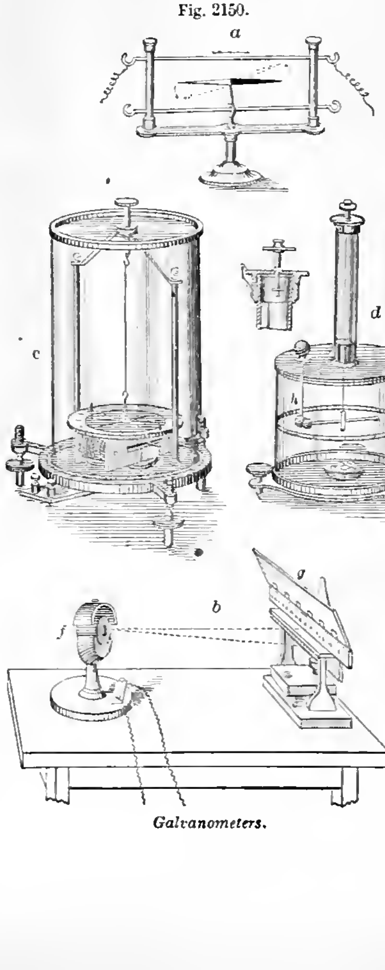
Gal'va-nom'e-ter. An instrument for measuring the strength of magnetic currents.

The instrument as usually constructed consists of a magnetized needle placed parallel to a wire, which, when electrically excited, causes the deflection of the needle. See ELECTROMETER; ELECTROSCOPE.

The discovery of this property in an electric current was by Œrsted of Denmark, in 1819. The principle was soon adopted by electricians in the construction of the indicator telegraph. Ampère, Arago, Schilling, Gauss, Weber, and Alexander all used the principle, but it received its perfected form by Cooke and Wheatstone, English patent, 1837. See INDICATOR-TELEGRAPH.

The tendency of the magnetic needle in the

Fig. 2150.



Galvanometers.

vicinity of an electrically excited needle held parallel to it is to assume a position at right angles to the wire conveying the current. By making the needle astatic, that is, by placing two needles with their poles in opposition to each other, they are not affected by the magnetism of the earth, and when thus arranged and surrounded by coils of wire the effect of the electric current is multiplied.

a (Fig. 2150) represents an apparatus for illustrating Œrsted's discovery. Two insulated wires are placed one above and one below a magnetized needle, and in a direction parallel to the magnetic meridian, and a current is passed through the wires; in the illustration, the current in the upper wire is represented as flowing from south to north, causing the north end of the needle to move to the west, and the south end to the east. A reversal of the current causes the needle to move in a reverse direction.

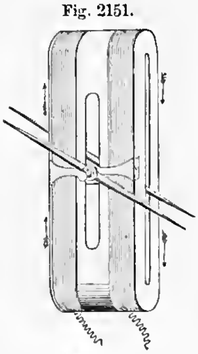
The astatic galvanometer *c* comprises an astatic needle suspended by a filament above a graduated plate, showing the degree of deflection. It is provided with set screws for attaching wires from an electro-magnet to the multiplying coil beneath the plate.

d is an instrument on the principle of the torsion balance of Coulomb, for observing the attraction or repulsion between the pole of a suspended bar magnet and that of a vertical magnet *h*. See INDICATOR-TELEGRAPH; TORSION-BALANCE.

Thomson's reflecting galvanometer, *b*, such as is employed in working the ocean cables, consists of a small mirror with a magnet laid across its back, both together weighing but 1½ grains. The reflector is suspended by a silk filament in the midst of a small circular coil of insulated copper wires *f*. A current transmitted through the cable and the coil induces a current which deflects the needle, and directs a little beam of reflected light from a lamp behind the horizontal scale *g* upon its graduated front; when the current is reversed, it sends the needle just so far in the other direction, and so by a combination of right and left motions and pauses the message is spelled out.

Gal'va-no-met'ric Mul'ti-pli-er. An instrument for increasing by repetition the intensity of the force of an electric current, as in the series of coils around the astatic needle of the needle-telegraph.

Fig. 2151.



Multiplier.

The convolutions of the wire carry the magnetic current a number of times around the needle, so as to increase its deflection, producing a considerable effect by a comparatively feeble current.

Gal'va-no-plas'tic Pro'-cess. One in which the obtaining of casts by electro-deposition forms an adjunct in the process of multiplying printing surfaces, or obtaining copies of articles of "*bigotry* and *virtue.*" See list under ENGRAVING; FINE-ARTS.

Gal-van'o-scope. An instrument for testing the presence of electrical forces.

It differs from a *galvanometer* in being merely qualitative, not quantitative, having no provision for determining the extent of the force.

Gam-ba'do. A leather legging for equestrians. It is wrapped around the leg, reaching from the knee to the foot, and is fastened at the side by clasps.

Gam'brel. 1. Originally, a bent stick like a horse's hind leg; used for suspending carcasses.

2. A roof with two pitches. A Mansard or curb roof.

Gam'brel-roof. (*Building.*) A roof with two sets of rafters at different inclinations. A *Mansard* roof. See CURB-ROOF.

Gam-broon'. (*Fabric.*) A kind of twilled linen cloth for linings.

Gam'mon-ing. (*Nautical.*) A lashing of ropes by which the bowsprit is bound to the cutwater to oppose the lifting action of the fore-stays.

Gam'mon-ing-hole. A hole cut through the knee of the head, for the gammoning.

Gang. 1. The rock enclosing a vein. *Gangue.*

2. A term applied to a set of tools so attached together or to a common stock as to act together; as a gang of bits, a gang-plow, a gang-saw, etc.

Gang-board. (*Nautical.*) *a.* A board with cleats, forming a bridge reaching from the gangway of a vessel to the wharf. A *gang-plank.*

b. A plank within or without the waist for a sentinel to pace.

Gang-cask. (*Nautical.*) *a.* A small cask for bringing off water in boats.

b. The cask in which drinking-water for immediate use is kept on deck.

Gang-cul'ti-va'tor. (*Husbandry.*) One in which a number of cultivator-shares are stocked in such a way as to be driven in a set; usually attached to a carriage portion on which the driver is mounted. See CULTIVATOR.

Gang-edg'er. A machine in which a movable and a stationary circular saw are mounted on one arbor for the purpose of dressing boards to uniform width, as they come from the log.

Gang-plow. Several plows stocked in one frame, generally supported on wheels and ridden by the operator.

Gangs of plows have been arranged for work by attaching a number of plows to a bar at proper distances, the motor being connected to the bar. The more usual form, however, consists of a number of plows attached to a frame which runs on wheels; the plows being the width of a furrow apart, and arranged in a receding order, so that the furrow slice, as it is raised, does not become jammed between the plows.

The wheeled frame, as used in the United States, is generally arranged with a tongue, so as to attach two or four horses, and when the plow is right-handed the off-wheel is the larger, as it runs in the furrow while the near wheel runs on the land.

The originator of the double plow seems to have been Lord Somerville, who devoted much attention to the practical details of agriculture (1799).

Fig. 2152.

Somerville's Double-Furrow Plow.

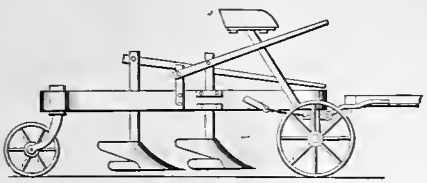
His plow, which he called a *double-furrow plow,* consisted of a beam suitably bent for the attachment of two plows, one placed laterally and to the rear of the other, as usual. Mr. Ducket of Esper, England, used, in 1797, a double plow, drawn by four horses, and turning two furrows.

The plow was not commended in England, especially in those places where it took and yet takes two persons to manage one plow. The idea of making one man operate two plows was preposterous.

Lord Somerville invented a movable-flap moldboard, by which the hinged rear portion might be set out or in, according to the width required for stubble or sod plowing. A set screw at the back secured the flap at the desired adjustment. It is shown in the illustration of his gang-plow.

In the example (Fig. 2153), the plows are moved vertically by levers. The axle is bent to depress the furrow-wheel. The tongue is attached to one side of the center, to suit the position of the horses.

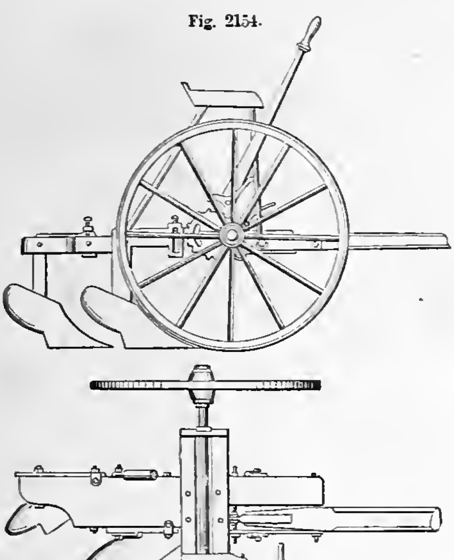
Fig. 2153.



Gang-Plow.

In Fig. 2154, the plows are raised or lowered by a lever and pawls attached to the axle, which has a toothed wheel, and has a crank near the hub for receiving the axle of the furrow-wheel, the tongue also being adjusted for the line of draught by a bolt through the clevis, and made fast to its rear end.

Fig. 2154.

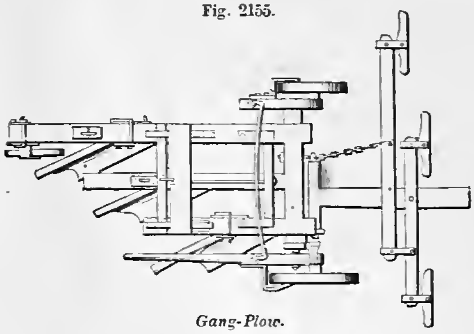


Gang-Plow.

The crank-shaped plow-standards, provided with a slot and set screw which passes through the boss and rests on the bed, are pivoted on bolts passing through a hole in the turn of the standard. The illustration shows a side elevation and a plan-view.

In the plow shown in Fig. 2155, the arrangement of the whiffletrees is designed to equalize the work of the horses. The levers, short axles, and sway bar are arranged to vibrate upon the ends of the axletree, for the purpose of raising and lowering the plow-frame. When the machine is at work the sway-bar rests upon the folding frame, but when it is desirable to depress the plows the folding frame is drawn from beneath the sway-bar, which then assumes a lower position and rests upon the plow-frame.

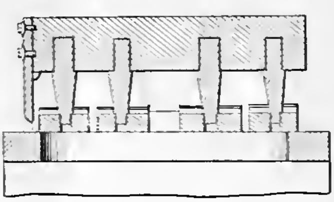
Fig. 2155.



Gang-Plow.

Gang-punch. An arrangement of a number of punches in a single stock for punching fish-plates, or other things.

Fig. 2156.



Gang-Punch.

Gang-saw. An arrangement of saws placed parallel in a gate, so as to make a number of kerfs simultaneously, ripping up the log into lumber at one passage along the ways.

In the large saw-mills of the lumber regions, these saws are known as *slabbing-gangs*, *stock-gangs*, *Yankee-gangs*, *live-gangs*, differing in certain particulars and purposes. See those heads. The arrangement of several blades in one gate was introduced as early as the sixteenth century.

The illustration shows an English form of the gang-saw. *a a* is a cast-iron framework bolted to the foundation; *b*, the saw-mill floor; *c*, driving-shaft; *d d'*, fast and loose pulleys; *e*, fly-wheel; *h*, pitman; *g g*, saw-gate, which runs on slides *l l*. The log is represented as lying upon the bearer *b*, which is a part of the log-carriage, which runs upon rails on the timbers *m m*, the log being held down by the bearer above. The feed is by means of the eccentric *l'*, rod *h'*, and ratchet-wheel *p'*. The running-back motion is by means of the pulleys *l'* and spur-wheel *q'*. The other parts perhaps require no detailed description.

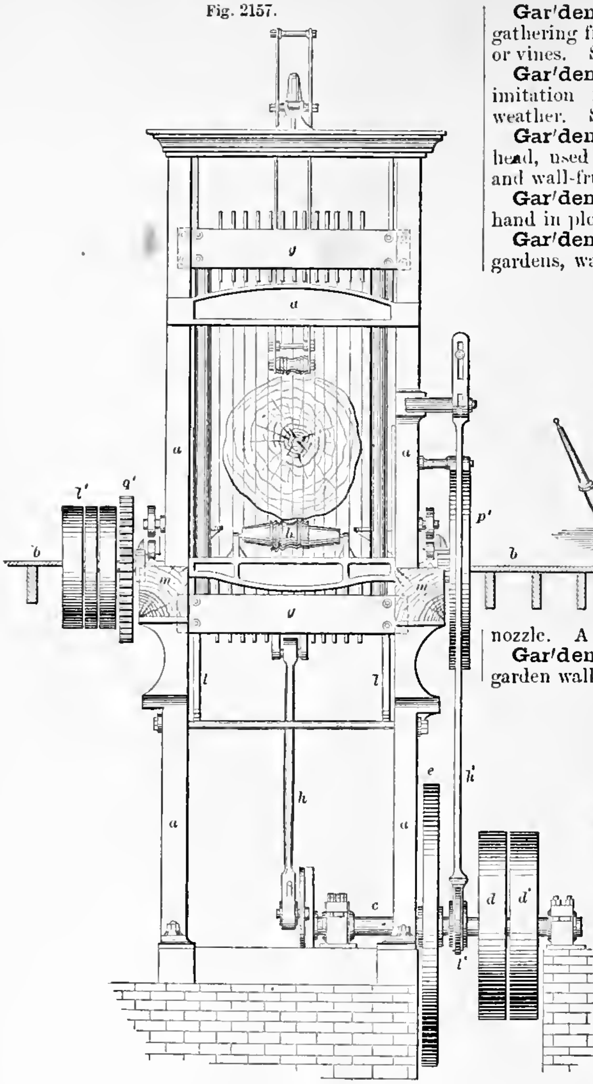
Gangue. 1. (*Smelting.*) The superfluous earthy matter of a smelting-furnace.

2. (*Mining.*) The mineral matters in which metallic ores are imbedded.

Gang'way. (*Nautical.*) The opening in the bulwarks of a vessel by which persons come on board or disembark.

Gan'is-ter. (*Metallurgy.*) A refractory material used for lining the Bessemer "convertors." It consists of crushed or ground silicious stone mixed with fire-clay. Its object is to save the iron convertor from destruction by the heat of the charge. Ground quartz, sand, and fire-clay.

Fig. 2157.



English Gang-Saw.

Atwood's compound for lining the bottoms of Bessemer converters consists of carbon, preferably that obtained from old crucibles, although anthracite or bituminous coal may be used, German, or other plastic clay, old ground fire-brick, Mount Savage stone-clay, and burned, or unburned sand.

These materials are ground together, and tamped into the mold.

Gap-win′dow. (*Architecture.*) A long and narrow window.

Gar′board-strake. (*Shipwrighting.*) The range of planks nearest to the keel. In the merchant service, the rabbet to receive the *garboard-strake* is made along the upper edge of the keel. In the navy, a groove is made half-way down the keel to receive the *garboard-strake.*

Gar′den-en′gine. A wheelbarrow tank and pump for watering gardens. See BARROW-PUMP.

Gar′den-er's-knife. A knife with a hooking blade suitable for pruning by a draw-cut.

Gar′den-er's-lad′der. A light ladder used in gathering fruit, pruning trees, or nailing up creepers or vines. See EXTENSION-LADDER; FRUIT-LADDER.

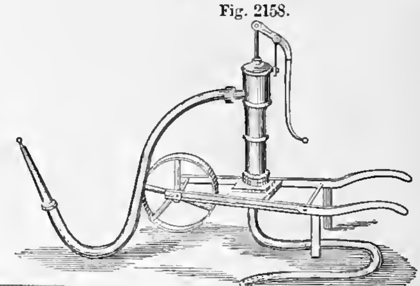
Gar′den-lounge. A seat of rustic work, or its imitation in iron, with an awning for summer weather. See GARDEN-SEAT.

Gar′den-nail. A cast nail with a pyramidal head, used for nailing up climbing plants, vines, and wall-fruit trees to brick walls.

Gar′den-plow. A small plow to be driven by hand in plowing between rows of garden plants.

Gar′den-Pump. A barrow-pump for watering gardens, washing carriages and windows. It has a

Fig. 2158.

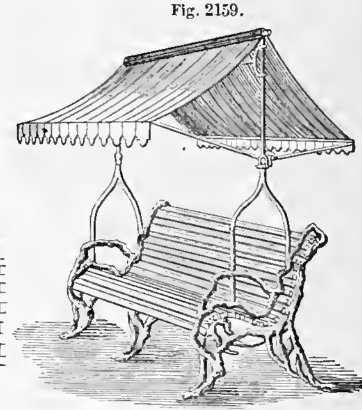


Garden-Pump.

suction-hose and a discharging hose and nozzle. A BARROW-PUMP.

Gar′den-seat. A seat for croquet grounds or garden walks.

Fig. 2159.



Garden-Seat.

Gar′den-shears. Large shears for clipping hedges and trees and for pruning.

Gar′den-syr′inge. A form of syringe for watering plants, sprinkling them with insect-destroying solutions, and so on. See GARDEN-PUMP.

Gar′goyle. A quaintly formed head of a man or animal, employed as a decorative spout for the rain-water from a roof.

Gar′land. 1. (*Nautical.*) *a.* A grommet or ring of rope, made *selvage* fashion, and used to place around a mast or spar when taking aboard or stepping a mast.

b. A bag-net used by sailors to hold provisions.

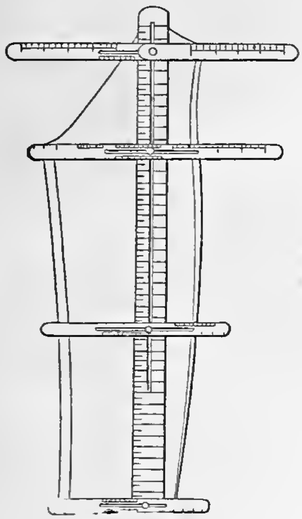
2. An ornamental band used in Gothic work.

Gar′lic-sep′a-ra′tor. A machine for extracting the corms of garlic from wheat in those States which are infested with the plant. The device is usually an apron or roller of a somewhat viscid surface, to which the corm will adhere.

Gar′ment-cut′ter. A machine having a descending cutter of a given shape, which cuts from a pile of cloth beneath it a number of pieces of its own size. The die is shifted for the next piece, and so on for each piece which goes to make up the garment. Used in large clothing manufactories.

Gar′ment-meas′ur-er. A measuring scale for laying out garments. The vertical and lateral scales are graduated for obtaining the sizes and proportions of the figure, being adjusted to agree with the measures as taken in the usual manner. At the upper end are scales adapted to the width of the back and the hight of the shoulder.

Fig. 2160.



Garment-Measurer.

Gar′net. 1. (*Nautical.*) A sort of purchase. Fixed to the main-stay as a hoisting-in tackle, but useful in other positions indicated by names, such as *clew-garnet*, etc.

2. A hinge of T-shape, the cross-bar being attached to the hanging stile or post.

Gar′nish-bolt. (*Building.*) A bolt having a chamfered or faceted head.

Ga-rook′uh. A vessel of the Persian Gulf, having a length of from 50 to 100 feet, a short keel, and a long overhanging prow and stern.

Gar′ret. An upper apartment of a house, immediately under the roof.

Gar′ret-ing. Small splinters of stone inserted in the joints of coarse masonry.

Gar′rot. (*Surgical.*) A tourniquet formed of a band and a stick, the former being twisted by the revolution of the latter.

Gar-rote′. A Spanish instrument of execution. The victim is fastened by an iron collar to an upright post, usually in a sitting posture, and a knob operated by a screw or lever dislocates the spinal column, or a small blade severs the spinal cord at the base of the brain.

Gar′ter. A semicircular plate, acting as a key, which passes through a slot in the wooden jaw of a bench-vise, and enters an annular groove in the cylindrical neck of the bench-screw, so that when the latter is unscrewed it brings *out* the jaw.

Garth. A fish-weir.

Gas. Exudations of gas from the earth have been noticed in ancient and modern times, and in many countries.

In China, these exudations, either natural or resulting from deep boring, have been utilized from time immemorial for lighting towns in the neighborhood of these jets. In boring for salt water, imprisoned reservoirs of carbureted hydrogen have been reached, and the gas thus obtained has been utilized in China, and in the valley of the Kanawha, West Virginia, in evaporating the brine.

Gas flowing naturally is or has been used in the neighborhood of Fredonia, New York; Portland, on Lake Erie; Wigan, Great Britain (in 1667); and in many other places.

The uses made of it by the Magi, or fire-worshippers of Persia, have not been properly examined or determined; but the holy fires of Baku, on the shore of the Caspian, have attained some celebrity, and are maintained by a natural stream of carbureted hydrogen.

Paracelsus remarked the disengagement of gas when iron was dissolved in sulphuric acid. Van Helmont, a Belgian chemist, gave it the name of "gas," and distinguished gases from atmospheric air, and also, on account of their non-condensibility, from vapors. Van Helmont died in 1644.

Oxygen was first discovered by Dr. Priestley in 1774; he obtained it by heating red oxide of mercury, and called it *dephlogisticated air.*

Scheele and Lavoisier a year or two later made the same discovery, independently of the English inventor, as Humboldt thinks. It was termed *empyreal air* by Scheele; *vital air* by Cordorcet. The name *oxygen* was given to it by Lavoisier.

Black and Cavendish, in 1766, showed that carbonic acid (*fixed air*) and hydrogen gas (*combustible air*) are specifically distinct aëriform fluids.

Gas was distilled from wood in Paris in 1802; from oil by Dr. Henry, in 1805; from refuse, oily, and fatty matter by Taylor, and patented in 1815.

The operations of the Chinese being unknown to the "outside barbarians," the streams of inflammable gas were for many centuries only objects of wonder and conjecture in the various countries of Europe where they issued from the soil. Occasionally, small bladders of gas had been collected and burned, but no suspicion seems to have entered the minds of the observers that there was anything valuable involved.

The artificial production of gas from coal dates in the seventeenth century, and the early examples of its manufacture and use are as follows: —

Dr. Clayton, rector of Crofton, England, distilled illuminating gas from coal, and detailed the experiment to his friend Dr. Boyle, in 1688. Dr. Boyle announced it to the Royal Society before his death, which happened in 1691. Dr. Clayton obtained what he called an "uncondensable spirit," which, as it issued in a jet, was caught in a bladder and used for experiments; the gas being repeatedly lighted and blown out.

About fifty years afterwards the account was published in the "Philosophical Transactions," and appears to have drawn attention to the subject, as from this point we find a chain of experimenters and then a line of practical developers.

If the series is to be briefly stated, we shall give it thus: Dr. Clayton, Bishop Watson, Murdoch, Winsor, Clegg; a clergyman, a bishop, an engineer, an enthusiast, a mechanic.

In 1726, Dr. Hales, in his work on "Vegetable Statics," states that 158 grains of coal yield 180 cubic inches of gas.

In 1750, Watson, Bishop of Llandaff, distilled coal, passed the gas through water, and conveyed it in pipes from one place to another.

In 1786, Lord Dundonald erected ovens or retorts in which he distilled coal and tar, and burned the issuing gas. He seems to have considered it an amusing experiment, and no more.

In 1792, Mr. Murdoch, of Redruth, Cornwall, England, erected a gas-distilling apparatus and lighted his house and offices by gas distributed through service-pipes.

In 1798, Murdoch lighted with gas the works of Boulton and Watt, Soho, near Birmingham. On the occasion of a public rejoicing for peace, 1802, he made an illumination of the Works; probably an outside exhibition of his pet, on the walls of the establishment. Trafalgar, Austerlitz, and Jena, within four years afterwards, is a curious commentary.

In 1801, Le Bon, of Paris, lighted his house and garden, and proposed to light the city of Paris.

The English periodicals of 1803 and thereabout refer to the proposition of Murdoch to use the gas obtained by the distillation of coal, and state that the use of the gas for light, heat, ammonia, or oil would be an infringement of the patent of the Earl of Dundonald; farther, that the amount of water produced by the combination of the hydrogen of the gas and the oxygen of the air would suffuse the curtains of a room with moisture, and would render it necessary "to wring out the curtains and other linen furniture of the apartments on the morning subsequent to the illumination by the burning of the coal smoke." — *Monthly Magazine*, London, June 1, 1805.

In 1803-4, Winsor lighted the Lyceum Theater and took out a patent for lighting streets by gas. He established the first gas-company.

In 1804-5, Murdoch lighted the cotton-factory of Philips and Lee, Manchester, the light being estimated as equal to 3,000 candles. This was the largest undertaking up to that date.

In 1807, Winsor lighted one side of Pall Mall, London; the first street lighting.

Westminster Bridge was lighted in 1813.

Houses of Parliament, London, in the same year.

Streets of London generally, 1815. Streets of Paris, the same year.

James McMurtrie proposed to light streets of Philadelphia, 1815.

Baltimore commenced the use of gas, 1816.

Boston, 1822.

New York City, 1825.

The Newton gas-well, six miles from Titusville, Pa., discharges at the rate of three millions of cubic feet of gas every day of twenty-four hours. The gas issues under a pressure of from twenty to thirty pounds per square inch, and for the most part goes to waste. Pipes have been laid to Titusville, and two hundred and fifty dwelling-houses, shops, etc., are now supplied with the gas for illumination and fuel. For heating purposes it is admirable, but for illumination it requires to be passed through naphtha, as it is deficient in carbon.

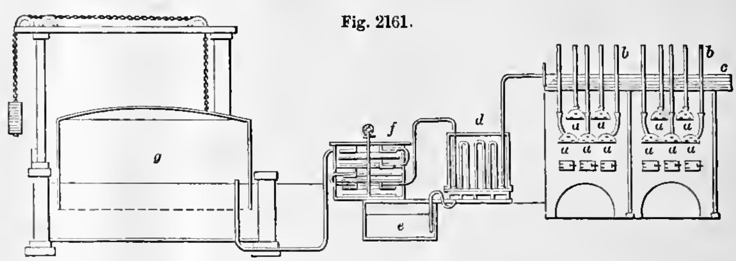
If the owners could satisfy themselves of the continuity of the gas flow, we presume that pipes would be laid from the well to several of the large cities, such as Pittsburg, Cleveland, and Buffalo.

The process of making gas consists in the distillation of coal, though other forms of hydrocarbon will yield it, and the subsequent purification of the same to purge it of noxious matters, — tar, ammonia, and sulphur. These operations are conducted respectively in the GAS-RETORT, CONDENSER, WASHER, and PURIFIER (which see).

The coal is placed in the retort *a* by means of long scoops, which are handled by three men, two scoopfuls forming a charge, — 220 pounds. The retort is of iron or clay; the latter is now preferred. The retort has its open end exposed at the furnace-wall, so as to receive the charge, and is surrounded by the flames and heat of the furnace. Each retort is connected by its branch pipe *b* with the main *c*, which conducts the gas evolved to the condenser *d*. The operation of charging the retort is quickly and skillfully performed, so as to limit the escape of gas. When the charge is introduced, the cap is replaced and luted to make the joint gas-tight. The fire expels the gas from the coal in the course of five hours, and the coke is then ready to be withdrawn. This is done by long rakes, and it is wetted to prevent its burning. The coke weighs less than the coal by the amount of gas evolved, but is nearly double the bulk.

The gas flows in company with other vapors from the retort, and these impurities are removed by successive operations. It is first conducted through the convoluted pipes of the *condenser d*, by which the gas is cooled and the tar precipitated. From thence it passes to the *washer e*, in which it is brought into intimate contact with water to remove the ammonia, which has so great an affinity for water that it leaves the gas. From thence the gas is conducted to the *purifier f*, where it is passed between layers of damp, powdered lime, arranged in a tier of shelves on a box. The lime absorbs the sulphur and permits the gas to pass off in a purified state, fit for consumption. See also GAS-PURIFIER.

Fig. 2161.



Gas-Manufactory.

The holder *g*, in which the gas is stored, consists of inverted sheet-iron cylinders, which are supported by chains and counterweights from pillars of iron. The cylinder is open at its lower end, and the edge dips into a tank of water, so that the cylinder rises as the gas is driven into it and sinks as it is withdrawn by consumption. The inlet and outlet of the gas is by pipes whose terminations are above the surface of the water. From the holder the gas proceeds to the mains and service-pipes. See GAS-HOLDER.

To govern the flow of the gas, a regulator or governor is applied (see GAS-REGULATOR), whose duty it is to limit the flow, according to the elevation of the locality to which the gas is supplied, and also to maintain an equable pressure to avoid flickering and inequalities in the light. One form of regulator is a bell-shaped chamber suspended from a beam whose other end has a balance-weight, being in construction similar to a gas-holder. Gas is admitted to the interior of the "bell" by a pipe whose end is above the surface of the water in the tank into which the bell is inverted, and a similar pipe conveys the gas away. Over the upturned mouth of the inlet-pipe is suspended a cone which partially closes the aperture when the pressure of gas is greatest, and uncloses the opening when the pressure diminishes, so that the size of the orifice is in the inverse ratio of the pressure, and the consequent speed of the passing fluid. Valves working on the principle of the bellows, and actuated by the ascending and descending bell, are effective for this purpose.

In the distribution, valves are used to cut off the

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